THE HUNTING WASP

by

JOHN CROMPTON

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By the Same Author

THE HIVE

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TO MY WIFE

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INTRODUCTION

THE NAME "Wasp" brings to mind a black and yellow thief who filches our jam or marmalade at meal times and spoils our fruit; a creature, too, powerfully armed and therefore to be treated with respect. At the end of this book we shall meet this unpopular character, but until then we shall deal with insects whose only resemblance to that brigand is a family connection and the same name, "Wasp." True, a few of these others wear the conspicuous black and yellow blazer of the school of Vespa, but resemblance ceases there. Their figures are different and the majority have colour schemes of their own, black and red, or pure black, predominating. In size they range from nearly double the size of a hornet to tiny ant-like creatures barely larger than midges.

These are the "solitary" or "hunting" wasps, and in no way do they differ more from the social wasps than in their manner of life. They are of course solitary, but that is only to say that they live in separate houses of which there may be hundreds almost touching each other. The houses are built (usually underground) by the females for the rearing of their young. The young are reared on meat, and meat only, while the mothers are vegetarians.

So when the time comes for her to be delivered the female hunting wasp forsakes flowers and fruit, digs a hole with a chamber at the end, kills some animal—a cricket, a caterpillar or whatever she fancies, or I should say insists on—and drags it to the chamber. On this corpse she lays an egg and hurries off to kill more game. These are placed alongside the first carcass and the chamber is sealed up. In due course, two, maybe three, days, the egg hatches and the emerging grub eats the corpse on which it lies and then goes on to the others. After from 9 to 14 days it spins a cocoon, becomes a chrysalis, and with a few exceptions remains thus until next summer when it casts off its shell and appears as an ordinary hunting wasp. It mates, digs a nest, and so the sequence of events goes on.

This is the rough idea, and it sounds simple. It is not quite so simple as it sounds. The reason it is not so simple is that these grubs cannot eat bad meat. Their meat must be fresh. Now these hunting wasps only operate in the hottest months of the year. So consider, say, a pile of twenty dead caterpillars (and some wasps store more than that for one baby) in a hot underground chamber. In a day or so they would become a putrefying mass jellied together in corruption—and the grub dies if it eats meat even slightly tainted.

What can the mother wasp do about this? Put them in alive, you will say, but you will get no marks for it. Apart from the fact that they would die of starvation, the egg of the wasp—and the grub at its early stages—is fragile. If an egg were dislodged by any movement of the body on which it lay, that would be the end of the egg. And the same applies to the young grub. As well might a human mother place her newborn baby in a stable of kicking oxen.

This problem did not escape the early observers. They were mystified because this bunch of dead caterpillars—or whatever they were—did not decompose when they ought to have decomposed. A Frenchman, Léon Defour, solved the problem to his own satisfaction and that of almost everybody else. The caterpillars were killed by the sting of the wasp, and the wasp at the same time injected a preserving fluid which prevented decay.

Now this sounds quite a good explanation if you don't study it too closely. If you study it closely it does not sound so good. What *was* the preserving fluid that could kill and also go to every minute part of the body and prevent decay?

Something pretty strong! People poisoned by arsenic keep longer than those not poisoned by arsenic, but it does not follow that you can eat them. Anyway the explanation did not satisfy a countryman of Léon Defour. Fabre shook his head.

I will not go into all the history of Fabre's search for truth. In any case he got it in the end fortuitously. He found some scarabs he wanted and had searched for everywhere, in the earth and in a state of perfect preservation. They were of course the cache of some beetle-hunting solitary wasp and Fabre came to his conclusion: those preserved corpses of the hunting wasps were not preserved at all, and they were not corpses; they were alive but carefully and scientifically paralysed. The idea *had* occurred to others, but only in a vague way. I have read old books that stated hunting wasps stored caterpillars damaged by the sting but alive. Fabre, however, was the first to clarify the position and unfold the story of the almost incredible anatomical knowledge and surgical skill possessed by this family.

If one suggests anything new one is subjected not only to disbelief but to abuse. Frow, the station-master, discovered the only cure for a disease that was exterminating our bees when experts, scientists, and University Commissions had failed to do so. He published his formula and gave it free to every one and as a reward was reviled. So was Fabre. He was ridiculed. Fabre was never popular; for one thing he wrote about insects in a way that every one could understand and his fellow scientists objected to this. It was breaking new ground and they wanted to make a mystery of it such as some medical men make of illnesses to-day. It was lowering their profession which had hitherto confined itself to treatises so dry and full of Greek and Latin as to be incomprehensible to an ordinary reader—which was what they wanted.

Truth of course prevailed. Experiments showed that the victims of the hunting wasps *were* alive. Corpses do not shudder when pricked, nor do they move their jaws about.

The problem the female hunting wasp has to solve is to provide a number of carcasses that keep fresh and at the same time do not move. What she really wants is a refrigerator but this is out of the question. So she solves the matter as we have seen, by paralysing her prey. This paralysing is not an easy matter; certain nerve centres have to be found and pierced and the dose while not inflicting death must be severe enough to stop all movement. A tricky business.

In the following chapters we shall study the operators at their work and classify them according to the prey they kill. The genera of hunting wasps are numerous; the various species infinitely more so. A mere list of them would almost fill a book. I propose therefore not to dwell too much on the species of each character but to use the generic name as far as possible. This will avoid having to plaster the pages with Latin and Greek names which make for difficult reading and often confuse the issue. Moreover, members of the same species—so far as hunting wasps are concerned—rarely act in the same way. One cannot identify the species by its behaviour. Indeed these solitary hunting wasps have more individuality than any animal I know.

The difficulties of observing insects and getting their life stories are considerable, and the hunting wasps present more difficulties than most. I have studied them myself in what leisure time I had—and that was often quite a lot, particularly in Africa—but I learned nothing new, so I will not pretend that I did. I have had to go elsewhere for my data. I have perused many books, but you will find in the pages that follow what may seem over-much of Fabre and of a Mr. and Mrs. Peckham. I cannot help it. I have had to go to the fountain head. These two blazed the trail. Most of what we know is due to them, and their knowledge was obtained with infinite labour.

But introductions should be as short as it is possible to make them. I am afraid that most of the characters that are to appear will be murderesses, but they have brought murder to a fine art, an act of exquisite precision. There will be little bungling on their part. Let us proceed.

CHAPTER I

THE CATERPILLAR HUNTERS

WHEN MOTHERS are unable to feed their babies in the natural way they give them some substitute in a bottle, and if one preparation does not suit, switch on to another. The mother of three or four children, however, has generally decided in her own mind which of these foods is the best and gives that food and nothing else to succeeding children. Arguments between her and other similarly prolific mothers frequently arise, one swearing by one food and another by another, and all convinced that they are right.

The hunting wasps are very like these human mothers except that they no longer experiment. There are, as we know, a large number of small creatures that crawl and fly and are more or less juicy and are, as it happens, very good food for baby hunting wasps. All these were presumably tried out at one time by the wasp mothers, but gradually each mother got a preference which the passing years have hardened into invarying practice. And so we find them now divided into classes, one class hunting grasshoppers, another beetles, and a third something else. And the leopard will change his spots before these mothers alter to the smallest degree the nature of their babies' food.

Reviewing the various foodstuffs on the insect market one is not surprised to learn that caterpillars are in strong demand. They are soft and juicy, can offer next to no resistance (though they can offer more than one might think), and their pathetic attempts to run away are hopelessly inadequate. Not only Ammophila but Eumenes and Odynerus prey on nothing else. For reasons which will appear when we introduce them we will leave Eumenes and Odynerus for a later chapter and confine ourselves for the present to Ammophila.

The word means "Sand-lover" and Ammophila is so called presumably because she prefers hard earth to sand. There are only four species in Britain but there are a great number in warmer countries. In appearance Ammophila is a little peculiar. Evidently they were wearing long waists when she came out, so that her abdomen looks like a pear on the end of a length of string. Nevertheless she is graceful and svelt. Her favourite colour is black with the upper half of her abdomen an orange red, giving quite a *chic* effect.

For a while Ammophila lives on and around the flowers, basking in the sun and sipping nectar. Her life is one purely of pleasure and differs in no way from that of a butterfly. But motherhood brings changes. It develops tenderness and affection side by side with a capacity for fiendish cruelty. Ask any hunter which he would rather meet, a leopardess with cubs or the larger and normally more formidable male. So when the egg begins to stir within her, Ammophila turns her attention to other things than flowers. She ceases to be a dawdler. She loosens the sting in its sheath—that as yet unbloodied sword, so slender and delicate, so feminine in its daintiness—and goes a hunting.

But first she makes a nursery. She digs a tunnel and a chamber in the earth—a bank perhaps, the edge of some quarry, the middle of a field, or the side of some footpath—bringing out the excavated material in her mouth and depositing it a few inches from the hole in two heaps. She works with solemn deliberation, methodical, tireless. The Hairy variety (which possesses no waist to speak of) is one of the exceptions and the feverish activity with which this species digs would call for grave censure from any builders' union. But normally about Ammophila there is a kind of rigidity as if she were suffering from rheumatism. Her shape is the reason. A swollen belly at the end of a long stalk may look fashionable but it hampers movement. For this reason Ammophila has to fly backwards, and when on the ground to move carefully lest her stomach get in her way.

Whilst out of sight mining in her shaft she keeps up a continual buzzing. A large number of the hunting wasps sing at their work but in Ammophila's voice there is something more menacing than pleased. Perhaps her idea is to scare away intruders such as the parasitic flies that are always on the watch to enter such nests as hers and lay their eggs on the provender laid down. *We* know the type. We have to be careful ourselves lest bluebottles get at the Sunday joint, but the consequences of an intruder are not so grave in our case. It means at the worst the loss of a meal for the ultra fastidious. For Ammophila it means the loss of her child. Should one of this unsavoury crew gain admittance its offspring would devour the food belonging by rights to the baby of the house and the baby of the house would die. It might be even worse, but we shall meet these parasites again so for the present will dismiss them.

The work proceeds and if the weather is warm the shaft and the little chamber will be finished in one day. This means a considerable amount of work, especially from a creature that has spent all its previous existence sun-bathing, but it is not the end ; before Ammophila can go off on her first hunt she has to shape her entrance, block up her front door and then arrange everything outside so that it looks exactly as it did before she started digging. She constructs a funnel-shaped entrance and then looks round for a suitably shaped stone to block the base of this funnel. She gives the stuff she has brought up and laid in two heaps a look over but probably finds nothing that appeals to her. She searches elsewhere, picking up a stone here, a lump of earth there, considering them and finally discarding them. At last she finds something that seems what she wants. She carries it to the entrance and places it in the funnel and cocks an eye. Yes, it fits; it will stop the loose stuff that she immediately begins to shovel down. Even about this loose stuff she is particular, picking out bits of earth and little stones and throwing them away. Her idea is to destroy all evidence that there is a nest there at all; to make the outside seem like the surrounding earth, level with it and differing in no way from it. This she does and to add to the deception cuts a little dry grass and spreads it with artistic carelessness here and there. She may even bring a ball or two of rabbit dung to further the effect, though this she will probably postpone until her final sealing of the nest.

No one now could tell that there was a nest there, and the maker herself, unless she is very careful, may regret the thoroughness of her own camouflage and be unable to find the place when she comes back from an expedition. She is alive to this possibility and does what she can to avoid it by marking with the utmost thoroughness the nest's position. She hovers in front of it, then flies round and round in widening circles, impressing each detail on her mind before she goes away. When she comes back she may do one of several things; she may find the spot unerringly, she may overshoot it or land too short, or too much to the right or to the left, or she may lose it completely and have to start all over again with another. Normally, however, she will find it without great trouble.

Photographed now in her mind are certain little landmarks: a stone, a tuft of grass, a small hollow, and other things close by. To prove it you may take away the most conspicuous of these features—that round stone, say—and put it in a different place not far away. Ten to one, on her return she will go to the exact position that her nest occupied relative to the stone; so far to its left or its right as the case may be. And she will search and search and dig and dig until she is almost distracted. If you are of a kindly nature you will put the stone back where it was before and then you will see her dig in the right spot and find the opening and you will note her pleasure and relief.

She has made her nest and covered it over and is now circling round it. Soon she will be off. Let us follow her and see her meet her victim; let us watch the killing of it. But first we ought to jot down what the slaughterer has to effect. She is after caterpillar. That caterpillar has to be reduced to complete immobility. If it were not, its wriggles and struggles might hurt her precious baby. She will bring about this immobility by thrusting her stiletto, charged with poison, into the nerve centres that control the movements of the body. These are very minute targets but they must be found. Outers or inners are not permitted; it must be the bull's eye. Those female relatives of hers who hunt, for instance, beetles will find at a certain place in the thorax the three main nerve centres, or ganglia, situated so close together that one stab will affect them all and the prey will fall as rigid and helpless as a man hit violently in the solar plexus, completely conscious but without the power of movement. With other prey the nerve ganglia are not so centralised; two stabs or three may be necessary according to the anatomy of the game. But a caterpillar is rather a peculiar sort of creature anatomically. As any one can see by looking at it, it is made up of segments joined together. In those caterpillars that Ammophila preys on (the young of night-flying moths mostly) there are thirteen of these segments and each is nervously self controlled. Each segment so to speak has its own power station so that if one is destroyed the other twelve can operate and the caterpillar can get along quite well. It is as if a car had thirteen cylinders and the sparking plug of one of them packed up; there would be very little difference to the running of the car. So what Ammophila has to do is to thrust her dagger with its charge into the nerve centre of each segment. Only by such a succession of stabs can this rigid vegetarian obtain the fresh and living meat fit for wasp babies.

I have never myself been present at the operation. I have never been in the operating theatre when any of the hunting wasps were engaged on their delicate surgery. I have seen

Ammophila astride her fresh and living kill, several times larger and heavier than herself, dragging it home, but I have not seen her use the lancet. A fly might be able to follow her about and be present at the crucial moment, but a large and wingless mammal finds it difficult. Mr. and Mrs. Peckham, however, have seen it and so has Fabre—several times—so we will follow behind them.

First the Peckhams. Only Fabre himself possessed the patience of these great Americans. Let me quote them:

> For a whole week of scorching summer weather we lived in the bean patch scorning fatigue. We quoted to each other the example of Fabre's daughter Claire who followed Odynerus[1] with unfaltering zeal until a sunstroke laid her low. We attended scores of wasps as they hunted; we ran, we threw ourselves upon the ground, we scrambled along on our hands and knees in our desperate endeavours to keep them in view, sometimes with our eyes upon the wasps themselves and sometimes pursuing their shadows; and yet they escaped us. After we had kept one in sight for an hour or more some sudden flight would carry her far away and all our labour was lost. At last, however, our day came . . .

The wasps often seemed to be having just as unprofitable a time as the Peckhams, hunting the underside of every leaf without result, then one flew up from the ground on to a leaf and knocked down a green caterpillar and dashed after it. As with most of the game of the hunting wasps the creature seemed to realise the dreadful nature of its assailant and with violent contortions of its whole body threw the wasp off. Again and again the killer tried to get a hold and again and again was flung violently aside by the struggles of the panic-stricken victim. Had there been cover near the caterpillar might have reached it and escaped its fate. But there was no

[1] A Hunting Wasp.

cover, the ground was bare, and at her fifth attempt the wasp got the other's neck between her jaws and straddled its body with her long legs. The creature lashed its body like a whip, but the executioner kept its head pressed hard down on the ground. Then, with deliberation, her abdomen felt under the writhing form and thrust its sting between the third and fourth segments. I have said that all the segments, or nearly all, must be stung to render a caterpillar immobile, and so they must, but the *immediate* effect of this dreadful stab and the injection of the largest dose of the huntress's poison was similar to that of a piece of lead piping applied behind the human ear. The caterpillar shuddered and was still.

The wasp kept her sting inserted in her prey's underpart for some little time, then withdrew it and with nice calculation thrust it into the third, the second, and the first segments. This was the first treatment and now she left her patient and took to the air and circled round it, judging its size and condition, or possibly the effect of her injections. Descending her jaws closed on it again—in the middle of the back this time—and with the precision of a surgeon her lancet was inserted into the ninth, tenth, eleventh, twelfth, and thirteenth segments. The middle segments therefore were spared.

The Peckhams were lucky enough to see a second killing by another Ammophila shortly afterwards and in this case all the segments except the end three were stung. Other observers have seen Ammophilae sting all the segments. Evidently therefore the middle segments, or the end segments, *may* remain uninjected—or possibly the wasp has no more poison left and must distil a fresh brew which is applied to the untouched parts on the way home.

The complete paralysing of the body by the sting is not the end of these operations. Either immediately after the stinging (in all the cases the Peckhams witnessed it was immediately after the stinging) or during the journey home the unfortunate caterpillar has to undergo further treatment. The trouble is that he can move his jaws and bite. It is all he can do now but it may be inconvenient; he has to be hauled a long way and may be able to grasp some vegetation and hold on desperately. This must not be. The movement of the jaws must be stopped. This could be easily arranged by stinging the subject in the head or neck, but this would cause death, an accident which the wasp has been at considerable pains to avoid. So she resorts to the delicate manipulative processes of the chiropractor. In her favourite position astride she bites the base of her victim's skull. She bites with care, putting a slight pressure on the brain and then raising her head to study the effect. The brain is a delicate organ and her patient *must* not die. She errs on the gentle side and compresses the brain again and again, twenty times perhaps, studying the result each time. And then she has only an inert load to drag home—bulky and heavy, but most dreadfully quiet.

And now I propose, if you are not sickened with slaughter, to pay Fabre a visit, for he is busy on a similar observation. The operator *he* is studying is the Hairy Ammophila, a lady we have mentioned already. She is of similar size to the other butcheress but without the fashionable elongated waist of the family. To the name "hairy" she might well take exception. Her thorax is covered with a slight and comely fur, that is all. It is as if she wore a woolly jumper. She goes in for bigger game, so big that she only has to kill one for each baby. This game is a creature that hides up during the day in crevices in the soil and comes out at night to wreck dire devastation on a variety of plants and crops by nibbling round their base. What its real species is I confess I cannot say, but Fabre called it the Grey Worm.

Fabre's scheme for witnessing a kill was to secure an understudy for the victim. He would get a couple or so of fresh unstung subjects and wait until he saw the wasp on her way home with her victim. Then, when the wasp left it to unlock the front door, he would substitute one of his fresh animals for the paralysed one (a trick that occasionally came off, but not often). So one day when he saw an Ammophila in his garden obviously searching for a grey worm he hastily called the gardener. "Favier,' he said, "come here quick. I want some grey worms." Favier was used to his master's idiosyncrasies and was also a good getter of grey worms. Without waiting to question why he got busy with his spade and his master waited (and one can almost see Fabre stamping his feet and gnawing his nails as he studies the wasp and wonders how long it will stay there).

At last Fabre's patience snapped. "Favier," he yelled, "where are those grey worms!"

Lugubriously came the answer, "I can't find one, sir."

Loud rose the master's voice, directed this time to the house behind, "Claire, Aglaé, all of you. Hurry up. Come out. Search for grey worms."

Evidently Fabre was blessed with a more obedient family than mine. There was no "Whatever for?" or "I'm busy peeling potatoes." The whole fmaily came out on the word of command and searched for grey worms. And what is more they searched for three hours during the whole of which time Fabre kept his eyes on the Ammophila which searched also with equal diligence and equal lack of result.

It was hot. There was a hint of thunder in the air. A storm threatened. Doubtless the grey worms knew that a storm was coming and had gone deep down. Suddenly it occurred to Fabre that the huntress might know a little more about her own business than he did. Might there, in those crevices she kept investigating, *be* a grey worm? Did she, perhaps, discard a crevice not because there was no worm there but because she realised she could not get at it? He took out his penknife and started digging in a crevice the insect had just left. The wasp saw this manœuvre out of the corner of her eye and greatly intrigued at finding intelligence in such an unexpected quarter came running back. Fabre stepped aside and the Ammophila immediately began to scratch at a certain spot in the excavations made with his knife. Fabre took the stage again and dug deeper into that exact spot while the wasp looked on with eager anticipation and very soon a surprised and indignant grey worm was chiseled out.

After that it was, as Fabre expressed it, like a hunt for truffles, the Ammophila taking the place of the dog or pig and pointing out the right spots. There was nothing whatever to denote the presence of a caterpillar in any of the places indicated, but the insect knew which crevice held one, and where. Fabre secured four and kept them, but he allowed the wasp the fifth, which she unearthed with his help.

He then described what he termed the "gorgeous drama" that passed before his eyes. He was lying on the ground, close to the slaughterer, and no detail escaped him. The Ammophila seized the caterpillar by the back of its neck with the curved pincers of her jaws. The big and powerful grey worm struggled and lashed itself about but the wasp was cool and unconcerned and kept the creature's head well down, moving aside when necessary to avoid the blows of the writhing body. Then, with care and deliberation, the sting was inserted in the joint between the first segment and the head on the median ventral line and kept inserted for some time.

After this a strange thing happened: the vivisectress left her prey and fell into convulsions on the ground. It alarmed Fabre. She rolled and fluttered. Merciful heavens! he thought, the poor creature has received some wound in the contest, some crushing blow. What misfortune! Then, abruptly, the wasp recovered, smoothed her svelt form, gave a saucy curl to her antennae, and returned to her wounded prey in order to have further dealings with it. The flutter had been a roll of glee, like the roll of a Spitfire that has bagged a victim or of a cat beside the body of a dead or injured mouse. Undoubtedly these Ammophilae gloat over their operations.

She seized the helpless form, this time a little lower down the back and inserted the sting with methodical precision into each segment as far as the ninth, backing and grasping her prey at a fresh spot for each insertion. The last four segments were not treated. Very little resistance was offered by the victim after the first prick of the needle. The operator now used her forceps on the head. She crunched and looked down to note the effect. Leisurely she crunched again, and then again, in all about twenty times.

And now, having secured the food for her unborn baby, she left the corpse where it was and rushed to the nursery. She widened the aperture, removed a pebble here and a lump of earth there so that there would be more room for the passage of the bulky carcass. She also went inside and made the nursery itself a little larger. Then she went back to drag her victim home. It had been better had she not been quite so fussy about the size of the passage way and the room. She had been absent too long and when she got to the body it was covered with black ants. She looked at it and probably heaved a sigh. She had met with this kind of thing before, I expect. She might drive off a few ants: but for what purpose? The bulk would remain, and those driven off would return. She walked slowly away.

Fabre, of course, did his best. He had four grey worms, you will remember, disengaged. He gave them to her, but she looked at them without interest and walked sadly on. The threatened rain was already falling. The curtain fell. The "gorgeous drama" was over.

Fabre witnessed a large number of Ammophila killings and in the majority of cases *all* the segments of the caterpillar were stung.

When Ammophila has stung her caterpillar and cleaned herself after the struggle, she turns the body on its back, puts herself astride, and grasping its throat in her pincers hauls it along. It is a laborious affair; it reminds one of a man astride a heavy pole moving it by laboured jerks. The action is not unlike that of a lion dragging an antelope; the lion also seizes the prey by the neck, or shoulder and holding its head high (as does the Ammophila) walks along, the body trailing between its legs. Eventually, getting near home, she drops her load and goes off to open up the shaft—assuming that she remembers where it is. The shaft opened, she brings up the caterpillar and carefully arranges it with its head at the entrance. She backs into the hole, seizes the caterpillar by the head, and pulls it down the passage way into the little room. And here without delay she lays her egg on its flank, about the middle. No more eggs will be laid in that nursery, but other paralysed caterpillars may be brought in. The number varies according to the size of the carcass. Some give their baby one, some two, others a dozen or more. The Hairy Ammophila, as we know, supplies only one, but it is a big one.

Having done her best for her child and gone to considerable pains to provide for it, the mother now gives it her blessing and departs. She seals up the nest with extra special care, camouflages it artistically, and returns no more. For a day or so she resumes the life of a lady of leisure, flitting amongst the flowers and flirting with the males. But one baby is not enough. The race would perish thus. Soon she is making another shaft and preparing for another accouchement and more slaughter.

Let us leave her here, on the flowers, and go back to the chamber of horrors she had just sealed up. In that dark shaft lie a number of motionless bodies: or almost motionless: their jaws move, for the brain treatment had only a temporary effect, and a barely perceptible throbbing under the skin shows that life still pulses. On the side of one is a small white cylinder, the ovum of the creature that is to complete the massacre started by its mother. In two or three days a tiny white legless grub emerges and nibbles into its bed which is the flank of the living caterpillar. It is a delicate little thing, this baby, and a mother's tender care has given it game that can be eaten without resistance. Anything that moved might bruise the infant against the walls of the shaft, or knock it from its purchase and it would die. So the caterpillar, with the exception perhaps of a slight squirm or a shudder, stays still. Or so it used to be thought. European observers have always found it so. Fabre has said that it always *is* so, and he devotes pages of admiration to the surgical skill of the vivisectress that never fails to succeed in such a delicate and tricky operation. But the observations of the Peckhams do not quite bear this out. That this is the desired end, they agree. But in twenty-five per cent or so of the specimens they examined things had not gone exactly according to plan. Ammophila, in fact, like other surgeons, had occasionally bungled. Her knife had sometimes gone too far and sometimes not far enough. In one shaft they unearthed, quite a lot of the paralysed caterpillars wriggled violently when pricked; and one or two, at the first bite of the larva, reared up on end. Others, more fortunate, were dead. And the larva ate the lot. Moreover this larva managed to retain its hold on those that wriggled.

What conclusions shall we draw from this? I think we may say that, in spite of the evidence, precise and exact stinging *is* necessary. Those larvae that retained their hold and continued to lunch on bucking caterpillars were not in their normal surroundings. Such a *contretemps* in the narrow confines of the shaft might well have had a less happy result. I think we may also say (in fact we shall show proof later on) that fresh meat is, if not essential, very desirable, and that if the game is dead it must not have been dead long. It is significant that quite a number of the Peckham's larvae died before they reached maturity in the shape of a cocoon. Certainly they saw one that *did* spin a cocoon after eating a dead (they did not say how dead) caterpillar but we do not know if it ever emerged as a perfect insect or perished of indigestion in its cell. After all, *human* children often eat things they are not supposed to and which send their mothers crazy with worry. In fact I know a child of four that once ate about a dozen dead tadpoles, with no more effect than a craving for more, but it does not follow that such is a normal diet, or one which if continued over a long period might not have ill effects.

How did Ammophila acquire the instinct to operate so skilfully? There are no classes in anatomy held amongst the hunting wasps. I think there is only one answer: the grubs whose meat became putrid died. In other words, only those mothers whose sting—by chance in the first instance—incapacitated but did not destroy had successors. The rest followed automatically by a process of continual and remorseless extermination. It may be asked why, sooner or later, all were not killed. Doubtless in the case of many species all were and the breed was written off, and doubtless many other forms of life are in the process of being written off to-day, for evolution is always at work in one direction or the other. We see only the survivors who have managed to adapt themselves. There are difficulties about the theory, I know, and if we take the short-sighted view the whole thing seems impossible. Because a mother, by a fluke, hit upon a nervous ganglion with her sting it does not follow that her child will. But you might say that about most animals; because a wren built a certain type of nest there was and is no reason why her children, who never see the work in progress, should build after the same complicated pattern. Of course not! And yet they do. We have to take the evidence of our own eyes and it is no use arguing that it is impossible for a certain thing to happen that we *see* happening every day.

Fabre goes to great length to pour scorn on the idea. He says in his final way that the art of preparing the larva's provisions allows of none but masters and suffers no apprentices; the wasp must excel in it from the outset or leave the thing alone. He then goes on to describe how, as a boy, he visited a slaughter-house and saw an ox killed. It was held straining at a rope while a man inserted a knife, hardly bigger than a penknife, into a spot at the back of the neck near the head. The great beast shuddered and fell as if struck by lightning. This is, or was, the method used in the *saladeiros* in South America and the skilled slaughterer who uses the knife is called the *desnucador*. Now the *desnucador learns* from others, his father perhaps, exactly where this spot is; how to feel for it with his fingers and how to recognise it when he touches it. He is not born with the knowledge, which originally must have been discovered by chance. Then *if*, Fabre goes on, the Ammophila, a far greater expert than the *desnucador*, hit upon her art by chance and now passes it on to her children (whom she never sees), why does not the *desnucador* do the same thing? Why has his son to be taught it?

Fabre, of course, takes the short-sighted view. He does not appear to realise what time can do. He has, indeed, no conception of Time with a capital T. None of us have if it comes to that. Not one of us can grasp the measure of 100,000 years. Our only chance is to think it out by centuries, and the mind soon rebels. Even the terms "All eternity" and "Life everlasting" fail to bring it home to us. And yet this period is negligible where evolution is concerned. And when you stretch it out and add nine other of these incomprehensible periods and get a million years, this hardly counts either. You can scrap the lot and start again if you like; it won't make much difference. But when you *do* get into the realms of *big* Time all sorts of things happen: lizards change to birds, small land animals go into the sea and become whales, creatures called men appear on a surprised and, one hopes, gratified planet, and hunting wasps learn to paralyse their prey without killing it.

CHAPTER 2

THE BEETLE HUNTERS

AN ONLOOKER from another planet (or even from this one) noting the huge army of insects and others arrayed against *Homo Sapiens* would find it impossible to believe that men had ever a moment to spare for fighting amongst themselves. That they find not one but several moments we know too well, but if some of the energy and talent devoted to internecine strife and the manufacture of bombs could be turned against the forces that have declared total war against us we should, for once, be engaging in a strife that would bring in some profit at the end instead of the usual poverty. Ignoring the all-conquering bacteria there is plenty of scope for our strategists and inventors in the war against insects—to use the word in its wider sense.

The battle so far is going against us. Like the U-boats, the insects strike at our supplies. The Colorado beetles have invaded England (a thing Hitler never managed) and formed a spear head. There is not a plant we grow nor an animal we raise that is not subjected either to heavy frontal attacks or guerrilla raids. Consider, for instance, the fruit tree pests. Once it was thought that sprays had solved this problem. They have made it worse. They have largely killed off the insects that destroyed the pests and have struck a treacherous blow at our chief allies, the bees, who augment our supplies of sugar and give us all the fruit we have. What would we think of a general in one of our own wars who directed his artillery indiscriminately against the enemy and his own troops? Further, these enemies are developing resistance to sprays. Fluids that killed their ancestors no longer affect them. And as new sprays come into use we may expect similar resistance to follow. Apart from this type of enemy action, termites and beetles have destroyed more houses and property than all the German bombers put together; while flies, mosquitoes, fleas and others wage a bacterial war of a type contemplated but never actually used by the Hun.

It is all very difficult and I have no cure at all to suggest, That is what I mean: the inventors of explosives and the planners of offensives in human battles need not be ashamed —if they ever get the time—to take a hand in this other campaign. It will not be a walk-over. There will be no sudden collapse on the enemy's part and no capitulation however stern the punishment.

Inconspicuous but formidable are the enemy's divisions of beetles and weevils. They are catholic in their destruction and they and their larvae attack most of the things we grow, both before and after the harvest. From time to time rewards have been given for the killing of the more destructive animals. The temptation to try to eradicate pests by offering rewards for their dead bodies (or identifiable parts) is one that those concerned always find difficult to resist. The British Government, frightened by the threatened invasion of the Colorado beetle, recently decided to offer a reward for every beetle found. In order to encourage people not only to capture what beetles they might see, but also to read up what the Colorado beetle looked like and make careful and systematic hunts for it, they decided to make this reward a substantial one. £10 for every Colorado beetle was the price.

It was money, as they say, for old rope. One only had to smuggle four or five of these beetles in a little cage into England to pay for one's whole holiday on the Continent. And if one were still more enterprising one might consider breeding from them. The reward was hastily withdrawn. A man was found in the possession of four in a cage brought over from Belgium on which he anticipated a profit of £40. Instead, he got a fine.

No, it was not a clever scheme, and it is surprising that this man, when he found he was suspected by the authorities, did not release his four beetles and thus avoid the fine. Doubtless a number of others did.

But other governments, too, have fallen into the same trap. It seems such a simple short-cut. Turkey, to reduce if not to exterminate the number of ownerless dogs, gave a bounty for every dog's tail brought it. The scheme seemed a success from the beginning for dogs' tails in large numbers came pouring in. But soon it was found that while the number of dogs without owners remained about the same, those without tails were rapidly increasing. A dog can breed just as well without a tail as with one and produce further tails that way. Then a penny was given for every dead scorpion, and in another country a similar reward for ever dead adder. In both countries farms were started, scorpion farms in the one, adder farms in the other, and the industry promised to become one of the most successful branches of agriculture—until the payments stopped.

A bounty on ears led to earless coyotes in Canada, so Australia, to circumvent this sort of thing, put their bounty on the *scalp* of sheep-killing wild dogs. One can hardly detach this part of the animal without causing death, but there remained the other way. Every year the amount of scalps sent in to be cashed doubled, and the increase looked like going on in the same proportion. Had the payments continued—which after four years they did not—very few sheep farmers would have been left; all would have been concentrating on breeding wild dogs.

France some time ago with crows, and America recently with rats, have discovered a fool-proof system. A number of these pests are caught and ringed, and a very high price indeed paid for a ringed crow or rat returned to the authorities. Thousands therefore are shot or trapped in the hope of getting a ringed one. I understand that in America the scheme is succeeding far beyond expectations, the number of ringed animals returned being remarkably high. Soon more may be returned than were released. It is not difficult to imitate rings.

One branch of the hunting wasps has joined us in the campaign against beetles but its assistance I am afraid is negligible. There are not enough of them and their methods are too slow. Still, next to the heel of a boot on a stone pavement they are about the only things that *can* make much impression on an adult beetle. These slayers of beetles are the hunting wasp family known as Cerceris.

Whereas Ammophila dressed as a rule in a colour scheme of black and red, Cerceris wears the well-known yellow and black livery of the senior branch. Though corseted, she is fuller in the waist than her social cousins and the waist joins the abdomen with a curve quite unlike the somewhat angular top of the common wasp's lower part. It reminds one of the waist of an Edwardian lady. If you really want to identify Cerceris from any of the others—and there are many—who wear the same house colours, examine her abdomen. The end of each segment presses as it were into the flesh forming a bulge as if a tape had been tied. You will have to look carefully, for Cerceris has a trim enough figure and the bulge is slight, but it certainly gives the impression that she is trying to reduce her abdominal contour. And this holds for every member of the genus.

She is a little Edwardian in her ways, too. Many of the others exhibit a democratic "mateyness" with intruding humans, but Cerceris likes her privacy and should she be looking out from her house, as she often is, and catch your eye, she withdraws in an offended way making you feel rather guilty. Her house is different from the house of her cousin Ammophila. The latter, when all is said and done, is only a shack. Hers consists of a long passage way with rooms on either side. The doors of these rooms are kept locked, though the front door is generally open. Bluebeard had only one room that he kept locked; she has several, and she has quite as much reason as Bluebeard for locking them.

There are six species in Britain, but one of these (*Cerceris rybyensis*) does not come into this chapter for it joins the hateful mob in Chapter 3 who kill, not the destructive beetle but our greatest friend the bee. There is another such unworthy member of the family living abroad (*Cerceris ornata*), but most families have their black sheep. Excluding these back-sliders the Cerceris huntresses go in for beetles in a big way. And they do not always display the rigid conservatism of many of the hunting wasps that keep strictly to one species, avoiding others so similar that scientists can hardly tell the difference. Their prey is often selected from the Rhynchophoras of the order Coleoptera, known as weevils, and as a class probably the most destructive of all the insects. (And I am well aware that a weevil is not an insect, and to avoid further explanations and apologies I would like to state here that I do not intend in this book to keep within the correct scientific bounds of that term. "Insect" is too useful a word to be so circumscribed.)

Why the Cerceris have selected beetles is a mystery. It is difficult to think of more unpromising material than these heavily armoured creatures. At almost every part their thick mail protects them against assault. In only one respect (from the wasp's point of view) are they better than caterpillars: the nerve ganglions controlling the movements of the wings and legs are only three in number, and in those beetles the wasps patronise—such as scarabs and weevils—these three ganglia are situated so close together in the thorax that one stab with the lancet is, assuming it hits the mark, sufficient.

And now I think, without further preliminaries, we will go straight into the arena and watch the fight. The lady Cerceris has marked a beetle for her own. It may be a beetle lovely with metallic sheen, bronze, emerald, and ruby, or it may not; it may be a drab weevil. Whatever it is it will be self-confident in its iron suit. Even the common wasp with its thick and powerful sting, or the hornet, no more think of attacking a beetle than a stone wall. In addition to being armoured the beetle is probably twice as large as the huntress and almost certainly twice as heavy. It is as if a giant in a suit of armour faced up to a slim girl carrying a stiletto in her stocking. Almost before the beetle has had time to cast a leisurely look upon her she has sprung on to his broad back and seized his long nose between her jaws. It is a good place; the most painful hold she could think of. It is the hold used on really vicious mules or horses when they will not submit to being mounted. A leather thong is twisted round the skin of the nose and the animal stands rock still until the thong is unwound. It "creates" then, of course, but by that time the rider is on top and if he is thrown off he has no one to blame but himself. The beetle reacts somewhat differently; instead of standing still the pain makes him rear up to the full extent of his legs. Probably an upward pull by his assailant accounts for it. Her forefeet press down on his mailed back and her jaws pull upwards as she tries to make him bend his body.

The beetle of course thinks he is in for an ordinary fight; an exceedingly painful one at the moment but once he has got his nose free he will show this she-devil a thing or two. He does not realise that this fragile but wiry sportswoman now has her abdomen searching under him and that while she seems to be fighting in a more or less clean fashion she is manœuvring for a foul well below the belt. But while that cruel pressure on his nose continues he can do nothing. He must submit even to the pressure on his back which is bending his foreparts upwards and incidentally exposing the small chink in his armour underneath. It is this chink she is feeling for, and suddenly her delicate weapon flashes in. Twice again she stabs him in the same place and the beetle falls paralysed from head to tip of scaly wing casing.

Cerceris steps aside, smooths herself down, curls her antennae and makes herself smart again after the tussle. The body lies at her feet but there is still heavy work ahead.

Overcoming a beetle and stabbing it is not just a matter of routine with Cerceris. It is a question of judgment and timing. The beetle is stronger than she is. Everything depends on that hold on his nose. To obtain it she must act quickly and at the right time. Anything that disturbs her or interferes with the precision of her movements is fatal. An observer once put a Cerceris and a beetle into a bottle and shook them up. The more stolid beetle was not so put out as the wasp. She made no attempt to go for him—but he went for her. The roles were reversed and he became the aggressor, seizing her by the legs while she tried to escape. Later we shall see other huntresses being bullied and maltreated by those normally their victims.

Fabre has gone into ecstasies of admiration and wonder at the "uncanny instinct" of these Cerceri in selecting for their prey the order Coleoptera, whose three nerve ganglia are so close together that all are effected by one stab. And he has reproduced the effect of that stab artificially on beetles of that order. He used fresh live beetles and (for a lancet) a pen-nib! The pen-nib was charged with ammonia. The results approximated to those of the slaughteress herself, but he could rarely get the right dose; too much ammonia and the beetle died, too little and, after violent struggling, it recovered. Still, he reproduced Cerceris's more expert administrations. But with the other classes—the beetles whose thoracic ganglia are apart —a prick of his pen-nib and its ammonia produced nothing but violent contortions, followed by quiet, and then by complete resumption of life as if nothing at all had happened. Second, third and fourth doses produced the same results until the wretched beetle died of the wound itself. It was after this that Fabre went into his ecstasies. Let me quote a part:

"The demonstration is conclusive; the Cerceris that prey on beetles conform in their selection to what could only be taught by the most learned physiologists and the finest anatomists. One would vainly strive to see no more in this than casual coincidences; it is not in chance that we shall find the key to such harmonies as these."

He does not say where the key *will* be found. Yet the key I think is very close at hand. He has, as we have seen, poured scorn on what he calls the "modern" theory, by which I think he means the theory of natural selection. Yet if he accepted it it would cause his difficulty to disappear and the piece which he holds in his hand, shaking his head the while, to fit with precision into the jig-saw that so puzzles him. For surely, once having chosen beetles for their babies, the Cerceris selection was inevitable. None but those of the order Coleoptera *could* be adequately stung by her. Therefore Coleoptera has always been her prey and she has no choice in the matter but to confine herself to that order, and it would be strange indeed if, after a vast number of years, she had not learned to recognise it. There *is* mystery in the case of some of the other hunting wasps who eschew species almost indistinguishable from their normal game and just as easy to kill—but none here.

In daring to question the conclusions of Fabre I am, I know, going out of my class. But Fabre the theorist is not Fabre the naturalist. He is as supreme in the latter field as Shakespeare in the field of poetry. His patience and perseverance leave one gaping with wonder, and have brought a rich harvest of knowledge to the world, but that does not mean that we must agree with him when he branches out in other directions.

But to return to Cerceris, whom we left, you will recall, smoothing down her waist and her taped abdomen. She has now to carry her prize home. It is twice her weight, but it is surprising how easily a heavy weight can be carried by air—once the carrier is airborne. She turns over the inert form she has so maltreated on to its back and again grasps its mutilated snout in her jaws Then, clasping the body between her legs, face to face, breast to breast, she struggles to rise, and having risen flies off with him. She alights at the open door of her house, drags him in, unlocks one of her rooms, and hauls him inside.

It is hard to feel sympathy for these enemies of mankind that destroy the produce he raised and needs so badly—the caterpillars and weevils and others we shall meet later—and which these trim little females do their small best to put out of action, but personally a shudder goes through me when I think of them in that torture chamber behind the locked door. That the smallest insect feels pain I have no doubt. Shakespeare in his now hackneyed lines, "The poor beetle that we tread upon in corporal sufferance finds a pang as great as when a giant dies," was, as he usually is, correct. Many think not. I remember a lecturer at an agricultural college describing some experiments on bees and remarking—apropos of something which does not matter—"*if* they feel pain—which I doubt." I can only presume he had not kept bees and had not jammed one when putting back a frame and heard the shrill yelp of anguish. For bees can yelp just as we do, and for the same reason. But he must have seen the reactions of any insect to heat. The contortions of the moth show that it suffers when it touches the open flame of a candle. I believe that some men—and some women, too—think that pain is a prerogative of themselves and that other creatures—even other humans—do not feel it, at any rate to the same extent.

They must ask themselves, what *is* pain? We make a great song and dance about it and dislike it profoundly, and this is because we are meant to do so. It is a primary emotion above, in nature's eyes, even the pressing urges of hunger and sex. It is an invisible armour. A most uncomfortable armour, and a prickly one, but I do agree with nature (reluctantly) that it is necessary. Without pain we should do idiotic things. Pain stops us doing them, often abruptly. And pain makes us fight twice as well or run away twice as fast as we would without it: a god-send in fact, a blessing in disguise—yes, certainly in disguise. Still, I must say I think nature overdoes it. You can have too much of a good thing. There is no object for instance in keeping *on* feeling pain in circumstances over which the subject has no control and about which he can do nothing. And sometimes she underdoes it. If only we felt pain in the early stages of cancer and other diseases the growth could be arrested. But pain is reserved until later when it is too late.

So pain, I am sure, is universal, and insects, and their grubs, too, get the warning just as any one else. But what about the wasp's victim ? Paralysed, can *it* feel pain? That it is fully alive, as fully alive as the most active beetle that ever popped into a crevice, we know, but I hope that the paralysis that has stopped the movements of its legs and wings has also stopped its feelings. I have never heard any theories about this. Probably because it is impossible to form any. If it does still feel pain it has a grim time coming. It has a grim time coming in any case.

If our rigid friend is the first in the room to which he is pulled, the egg is laid on him forthwith and on the exact spot where the stiletto was inserted. The mother rightly thinks that this of all spots is the one least likely to develop any twitchings or other movements calculated to inconvenience her precious babe.

Mothers are like that. They look at things from only one angle. The memory of my boyhood is getting a little dim now, but one event stands out and, I think, accounts for a right ear that has caused trouble ever since the episode in question. I was about thirteen and the scene of the tragedy was a road covered with snow that had melted and then frozen. A child of some four years flashed across my sober elder path shrieking joyously in the way these juniors do. His impetuous course on the glassy terraine met its inevitable end and he crashed heavily. I, as a perfect gentleboy, picked him up yelling and shrieking to high heaven, and put him on his feet. Unperceived by me, the call of her young had drawn from one of the massed houses on one side, the mother, a stout creature and powerful. She, with the absence of sober reflection so often apparent in the female, jumped to the conclusion that I, the rescuer, had assailed her offspring and was still in the process of maltreating him. The result was a blow on the right ear that laid me quite as flat as the child I had just righted up. When semi-consciousness returned and I had got up and was beginning to tell her the facts of the case I found she had gone, cum child, and was shutting the door. The echoing crash of that shutting door and the sense of the gross injustice of the whole thing has not faded with the years. One day I feel I will go to that town and that house and explain things to that woman and demand an apology. Or might the other ear get damaged too? One never knows with mothers.

The egg having been laid, other beetles are fought, paralysed and added to the store until there are sufficient to sustain the child until it spins its cocoon. It devours the first one, eating into the juicy centre and discarding the hard parts; then on to the next, and the next, and so on until in place of bodies there is an assortment of heads and legs and wing casings, the latter frequently glittering like jewels when they are unearthed. The mother desposits the necessary number of carcasses in a day or so, and her daily bag is about five beetles. She then seals up the chamber and opens the next door and repeats the performance for her second born.

The Peckhams have again rather upset Fabre's apple-cart. He does lay such stress on those two essentials—life plus immobility. But the Peckhams found dead beetles in the nurseries; not a lot, but some. Apparently Fabre never found any that were dead, though occasionally he found those that kicked, and he has examined more collections of these unfortunates than any one else. Perhaps American wasps are not so expert as ours. In any case it is not surprising that in such a delicate surgical operation a few slips should be made and one rather wonders that Fabre never found patients who had received an overdose.

The normal life of Cerceris is difficult to study. She is so shy. She rarely acts naturally when a human being is present and will even go to considerable trouble to fool him and lead him up the garden path by pretending her house is in some place where it isn't. And she has got a dreadful temper. The Peckhams caught one and put her in a bottle together with her prey which she was carrying home. Fabre's bottle experiment you remember was different: his beetle was unstung and he shook the bottle up. There was no shaking here, so the wasp was not frightened—she was merely annoyed. She dropped her prisoner, and then, finding she could not get out of the sudden transparent cage, threw all the blame on to the beetle. He must have been in a very unsatisfactory condition to punish, but she did so. She stung him several times in the neck and in the thorax. Then she tried to get out again and when her temper once more got the upper hand returned to him and subjected him to more chastisement. She did this four times with intervals of about five minutes in between. Then they let her go.

One is not surprised to learn that the beetle died next day.

CHAPTER 3

THE BEE HUNTERS

WE NOW COME to those whose activities meet with our strong disapproval. If the bee never made a drop of honey it would still be the animal the world could spare the least. "Preserve to our use," we pray, "the kindly fruits of the earth," but we do not pray for the bee who helps to get them. I am aware that other insects and some small beetles may effect pollination in the blossoms of self-fertile fruit trees; but most of our fruit trees are not self-fertile, and even if all were they need conscientious and indefatigable workers to set the fruit in the clusters we like to see. Other insects might give us an apple here, a pear there, and a plum somewhere else, but for all practical purposes fruit would be "off" without the bees—honey, bumble, and solitary. As a reward, every creature that can get at them pillages them or kills them or both.

Mammals, birds, insects and reptiles make a dead set at bees, but only one small class confines itself entirely to them: these are the hunting wasps that come under the heading of this chapter. And they, like all their relatives, have become so dietetically hide-bound that were bees to disappear these particular hunting wasps would disappear also the next season and be seen no more. It is, of course, their young who need bees—or so their mothers think; experiments have tended to show that the young of the hunting wasps can generally live on other things at a pinch, but you will never get the mother to believe this. So the babies of the bee-hunters must have bees—or nothing.

There *are* quite a number of species who kill bees, but I think we may congratulate ourselves that there are not more, because bees are unique in that they provide food both for the baby and the mother, the latter sucking the sweets from the bee before giving the corpse to the baby, and in addition often killing bees for her own consumption, throwing the corpse away as a child a sucked orange.

The point presents itself, in dealing with those who attack the hive bee: how can a slim huntress overcome a stronger opponent armed with an infinitely more formidable weapon? The answer is simple; you yourself could do the same thing. I mean you yourself could come up behind any one and stab him if he were preoccupied with a job of work and did not realise you were there, especially if you knew the right spot in which to sink your knife and were an expert in Ju-jitsu. Not only that; although Nature has given the bee the most powerful weapon for her size of any of the insects, she has not taught her how to use it. Perhaps she thought she would learn herself. She has not: she just uses it blindly when she gets annoyed. This is all right so far as you and I are concerned with our great areas of flesh, but no use with such skilled fencers as the hunting wasps.

England has no solitary wasps that, so far as I know, do any damage to the hive bees. There may be an odd *Philanthus apivorus* here and there but I have never heard of them, though Edward Step lists it as a British species. Our solitary bees are attacked by that Cerceris back-slider I mentioned in the last chapter (*Cerceris rybyensis*), and another member of the same normally immaculate family, *Cerceris ornata*, is a perfect fiend among the hive bees on the Continent. Latreille computes that within a radius of one or two miles settlements of these wasps take some 15,000 bees. Raeumur states that in the Isle of France no hive bees exist though they abound in the Isle of Bourbon, and he attributes this to the hunting wasps that are firmly established in the Isle of France.

These wasps either wait for the bees when they are coming home laden with pollen and honey, or haunt the flowers where they are busily engaged and get them there. The British undesirable, *Cerceris rybyensis,* generally takes the solitary bees, Halictus and Andrena, on the wing when they are loaded with stores. After stinging, the bee is hauled by its antennae to the wasp's home where its body is crushed and kneaded into pulp and the honey sucked out.

But the most notorious bee-hunters are the Philanthi, headed by *Philanthus apivorus.* This is a wasp half an inch or so in length with a big chest and a small stomach, and, as with us, a small stomach does not necessarily mean that she has a small appetite. She captures the honey-bee amongst the flowers and as it is dying she kneads its belly and from its lolling tongue drains the honey. Not a pleasant creature, and that is why I like a story of Fabre's wherein Philanthus receives herself some of the treatment she more generally doles out.

Occasionally, in France, a Praying Mantis visits what Fabre, with his gift for apt terms, calls the "work-shops" of the digger wasps. Most people who have been abroad know the Praying Mantis and will like Fabre's description; "Her long, pale-green wings, like spreading veils, her head raised heavenwards, her folded arms crossed upon her breast, are a travesty of a nun in ecstasy." How right the word "travesty"! The female Praying Mantis is the wickedest of all the fauna that walk the earth—and that is saying much. The devoutly folded arms possess long spikes between which she impales her victims what time she nibbles them alive. Particularly does she delight to deal sadistically with her husbands, who queue up for the privilege. Though "husbands" perhaps is the wrong word: they are more akin to those who line up at a brothel, and in their case the price charged for a fleeting pleasure—which they are not allowed to consummate—is indeed high. For the female in order to satisfy her own appetite or to stimulate her partner—or both—bites open his chest and often severs his head before the act is completed.

The Praying Mantis that Fabre saw was waiting at the workshops for returning wasps, thereby securing a double meal of wasp and victim, and Fabre saw it seize a Philanthus at the moment of its profaning its prey by sucking the honey from its mouth. The pious arms of the Mantis embraced them both and she began to eat the belly of the wasp. And while she ate, the wasp continued to lick the honey from the bee, "unable, even amid the terrors of death, to relinquish this delicious food."

There is one thing about all these preyers on the peaceful and industrious and necessary bee—they kill it. Grim as is its end there is no torture chamber waiting for it. I am not quite sure why this is so. The bee is stung in the neck, and that is a fatal mark. Perhaps the bee's hard chitinous armour makes it impossible for the wasp to sting it anywhere else. But the beetle had an infinitely harder armour and Cerceris managed to find a joint wherein a stab paralysed without killing. But the beetle has not a sting. The wasp who engaged in preliminary tactics and wrestling matches in order to make a bee bend herself and uncover a crack might well meet with an unpleasant surprise. If she got in the way of the bee's armament she would be in the position of a man who stops a shell from a six-inch gun. So I think she is wise not to linger over the affair.

Another point is that honey, so good for most children, is very bad for the young of wasps. These precocious infants must have flesh, raw and newly killed. They reverse *our* normal procedure; they only suck sweets when they become adult. So Fabre says that the bee is mashed up so that the honey can be removed before the carcass is given to the child. And he may be right, though I am not going to give the wasp any marks for motherly care on that account. I believe she removes the honey for the same reason that a child removes the cream from the inside of a bun. And does she not also kill for herself?

The Peckhams, talking about an American wasp, *Philanthus punctatus*, assert that it does not remove the honey from the bee before giving it to the baby. (The Peckhams and Fabre are always contradicting each other, or else American wasps are always disobeying the rules.) But, careful observers though they are, I do not think the Peckhams have quite proved their case. *P. punctatus* preys on those delightful little solitary bees called Halictus, who are as "solitary" as the inhabitants of Birmingham. The Halictus bees live in settlements of thousands in tiny holes almost adjoining, each hole filled with the little head of an Halictus bee on guard. Clouds of bees arrive continually bringing stores of pollen and honey, each to its own house. And into this scene of contented activity, as the Peckhams say, descends the ravaging *Philanthus punctatus*, taking guards and workers alike. The home of the Halictus bee is very similar to that of many of the hunting wasps. It is a long tunnel into the earth with chambers on either side, their interior surfaces lacquered and polished, and all the work of the one mother. The contents however bear no resemblance to those of the hunting wasps. They are innocent of slaughter: honey and pollen kneaded together like a batter pudding; then the egg, which hatches, feeds on the pudding and pupates.

The Peckhams' case rests on the fact that they saw the wasp go into its nest several times with a whole bee, and come out. But they did not see what happened to the bee before it was brought in, and they did not see what happened to it after it was brought in, though they say the wasp emerged very soon after storing it, which would hardly have given it time to pound the bee and suck the honey. They could not dig out the bee and examine it, for the nests have a main passage way (the various rooms lead from it) about two feet long that goes down into the earth and then curves round, and any attempt to excavate and follow it results in a complete collapse of the crumbling soil. Moreover they could not have known whether the bee captured *had* any honey, for bees do not always carry this commodity around with them like kind uncles with sweets in their pockets; it might have been bearing pollen, or water, or nothing.

The Philanthus home, more often than not, is an ancestral home, handed down from generation to generation who never see each other. When the occupants of the various rooms awake from their ten months' sleep and fling aside the blankets of their cocoons, they force open the bedroom door. Doubtless they look at the bee remains, the dried legs and wings, and shudder and wonder who on earth put them there and why; for they have reached the sweet-eating stage and carcasses revolt them. Later on they will turf these legs and things out and tidy up the room and will have no idea that they are clearing the table after their own meal. In the hall, or at the porch outside, brothers and sisters meet and introduce themselves. There will be seven or eight of them and the sexes are usually equally divided. They settle down and keep house together in great friendliness, visiting the flowers or looking out of the front door.

For as yet they know no evil. The brothers never do, except the evil of bone laziness, and the sisters are not thinking of babies yet nor the slaughter that babies bring. A bee—any bee, even the smallest—could come up and join them. The wasps would be shy, I expect, a little embarrassed or even frightened, but they would no more think of attacking it or being rude to it than a vegetarian school-girl would contemplate sticking a pig. So, much as we dislike their later ways, we can study them now with the same pleasure that we study baby foxes before they become of an age or rob the poultry run. Indeed, for the present it must be admitted they are rather nice little things.

The Peckhams gave considerable time to the study of one such family. It consisted of three brothers and four sisters, the sisters being larger and handsomer than the males, with perky little bright-yellow faces. The front door was always opened about nine o'clock in the morning, and the next thirty minutes or so provided the only occasion for any slight bickering amongst them. For each wanted to sit at the open door and view the world, and the opening was only large enough for one at a time. However, they soon came to an agreement and arranged that each should take the coveted post in turn and for a specified time. "So one after another their comical little faces would appear, each wasp enjoying the view for a few minutes with many twitchings of its antennae, and then retreating to make way for another in response to some hint from behind."

Then, when the half-hour was up, they would circle and fly away, leaving one member to look after the house.

This housekeeper, after they had gone, would retire inside, first, as a careful housekeeper should, shutting the front door by shovelling up sand from the interior. The rest of the family would be absent all day and come back one by one, never later than 5 o'clock. The first one to arrive would open the door and either go in and close it, or wait there for the next arrival. Sometimes, several would come back together. Once or twice they failed to find their front door. Had they, perchance, looked at the juice of some fruit when it was fermented? One hopes not. But a certain suspicion attaches to those who cannot find their front doors when they come home. On these occasions they would dig in several places, and one at last would find it and announce the fact to the others, and in they would troop, and the door would close, and that was all that would be seen of them until nine o'clock the next morning.

It was a week before motherhood, with its lust for blood, stirred in the breast of one of the sisters. She began to clean out the house with the feverish intensity of a woman smitten with the spring-cleaning disease. She even added new rooms—as was evidenced by the amount of sand being turned out and deposited some five inches from the door. Two days later another sister felt the same impulse. The ancestral home, I suppose, goes to the eldest—the first to leave her bedroom—for this one began to make a completely new house close by—two inches away, to be exact. I suppose the other two sisters flew away and also made houses for themselves, though this is not necessarily the case. Two of the brothers left, but two stayed on in the house and made it their permanent quarters.

The males give no help to the females, either sisters or wives, in killing, hauling, or digging, though they are very fond of watching the digging and will look on with great interest. Some stay in the old home all their days, living their own lives and paying no attention to their sisters' butchery, and some take up flats of their own. In doing this they rather give themselves away, for they can dig out very snug bachelor quarters. The question, then, may well be asked, why, since they can dig so well do they not sometimes help the females? The answer, I think, is simple and adequate—because they do not want to.

The observers of hunting wasps are always eager to see the actual slaughter. This is but natural, for the killing is the consummation of the huntress's art. But there is a thrill in it too and the spectacle, as entertainment, is not marred by any jarring sense of pity. Men and women who could not bear to see a weasel kill a rabbit or a cat a mouse will watch enthralled the death combat between a centipede and a scorpion or follow with relish every action of the sadistic Mantis with her victims. Myself, I hate to see a bee killed, but I confess I lose no sleep after seeing other insects laid low.

The way of Philanthus with a bee is very similar to that of myself with a cockerel wanted for the table. I used to let the gardener kill the cockerels—when we had any—but now that gardeners are so scarce and expensive I have to do it myself. I dislike doing it, so I have invested in a machine that breaks the neck of the cockerel scientifically and instantaneously. The cockerel however struggles a lot after the operation, but I am told by the instructions that accompanied the machine that it is really dead. Similarly, persons hung are supposed to be killed immediately, yet life is not officially pronounced extinct until a quarter of an hour or so afterwards. We shall never really know whether death *is* instantaneous in these cases —unless we like to try the experiment on ourselves. The bee, after the more expert ministrations of Philanthus, struggles less than the cockerel with the broken neck. There are a few movements; its mouth opens and shuts and its tongue lolls out. But a stab in the neck is deadly to practically all forms of life, and if the dagger is charged with poison the end is very swift.

Observers, of course, have gone into the matter. You cannot study this hunting wasp's methods in the open. That would mean watching bees all day with only a remote possibility of a Philanthus appearing. And if an attack *were* made it would be so swift and unexpected that one could not possibly see the details. As well decide to note the actions of the Golden Eagle taking a lamb by standing near a lamb in a meadow hoping for the best. So observers have had recourse to the invaluable bottle. One example will suffice: if you wish to see more bees killed do not come to me.

Into a bottle, then, an observer put a bee; a solitary Halictus bee. The bee, like any bee confronted with glass, thought only of escape. Then a Philanthus was introduced. The bloodthirstiness of these bee-hunters is exemplified here. Most hunting wasps in a bottle are as distraught as their intended victims, if not more so; both struggle to escape, and if they get in each other's way and vent their feelings in a blow or two, it is usually the weaker wasp that gets the worst of it. But in this case the wasp, seeing her hereditary game, attacked immediately, and the preoccupied bee found itself stung in the neck before it even knew a Philanthus was there at all.

The nest of the wasp was close by and it dragged the dead bee by one antenna up and down and round the bottle, but when a second bee was put in it attacked it at once without even letting go its hold on the first, and stung it with precision in the neck. Now this was a remarkable feat and I can only conclude that in its excitement it simply forgot that it was holding on to the first bee at all. It was as if Joe Louis, having knocked out Woodcock, took him under his left arm, and when Mills was introduced floored him with his disengaged right.

This wasp was then released and it flew straight off to its nest with the first victim. The experiment was repeated with other Philanthi and (of course) other bees. The results were the same except that before stinging their second bee the Philanthi always let go their hold on the first. All the bees were stung only once, and in the same place.

These wasps were taken in the middle of their butchering career. Other wasps that were making their nests but had not yet begun to provision them took no interest whatever in bees put into the bottle with them.

CHAPTER 4

THE GRASSHOPPER HUNTERS

THIS CHAPTER will not be confined to grasshopper hunters. Grasshoppers belong to the ancient order of Orthoptera, which includes crickets, locusts, cockroaches, and mantids. Earwigs have put in an application for membership and this, at the moment, is under consideration by the scientists. All those mentioned, except the earwigs, are commandeered as wet nurses from time to time chiefly by a hunting wasp family called Sphex. The chapter therefore must be subdivided; for the Sphex that preys on a locust will have no dealings with a grasshopper, and the cricket hunter would shun both. We shall try to get some order and method and to sort both Orthoptera and Spheges out, but that we are able to do so is only due to hard work and lucky chance on the part of naturalists, particularly that greatest of all naturalists, Fabre. A lot of us might not call it particularly lucky to have to wait twenty years to see an event lasting a few minutes that could be described in two paragraphs, but Fabre did.

Few realise the difficulties of studying the hunting wasps. Even to see most of them is a rarity; to find their nests, rarer; to find them with their prey, rarer still; and to look on at a kill is (to a naturalist) something like winning the Calcutta Sweep. Most scientists and naturalists take the comparatively easy path. They make "collections." They catch wasps and kill them and sort them out and label them. As O'Henry says, they catch bugs and stick pins in them and call them names. Now this is very necessary. It is not a bit of use Fabre, or any one else, going out and coming back and saying he saw a black and red thing, or a yellow one, killing a cockroach. He must know the name of the creature; and to know it specimens must have been caught, collected, and classified before. But it is a little overdone. Every large museum wants its collection and men are paid to get what has been got before. If the energies of some of the collectors could only be diverted to a study of the *lives* of the insects instead of their dead bodies our present lamentably small knowledge would be increased. As Fabre says, "Eats grasshoppers" means more, much more, than whole pages of minute description of wing nervures or measurements of *tarsi.* Stirring things happen in the insect world. There is romance, jealousy, hatred, courage, cowardice, cruelty, massacre, lust—just as in ours. We need men and women who will run in the heat or lie on their stomachs for hours at a time, go without their dinners, go without their teas, or come home at night for their breakfasts. And this, incidentally, postulates an equal need for wives or housekeepers who will put up with that sort of thing. One shudders to think what would have happened to natural history if Fabre had had a nagging or a domineering wife! Those who study insects visit a new world, and we should be disappointed with a man who went to Mars and came back only able to give us anatomical details of the inhabitants. The scientists perhaps would ask what we had to grumble at, but most of us would want to know *some*thing about the way the Martians lived and loved and fought and what they ate. Luckily, however, some of our naturalists *have* been interested in insects before they were dead and taken the hard and arduous road that leads to knowledge.

Sphex, even more than most of the hunting wasps, is a lover of heat. So are her prey. Neither grasshoppers nor crickets are numerous here and locusts are unknown. Cockroaches, unfortunately, we have in plenty, but only one variety, which came accidentally from the Orient, whence have come many unclean things including brown rats. Fabre states there are three Spheges only in France and these live chiefly in the hot south. In the tropics, as well as America, there are many more and not a great deal is known of their habits. But it is fairly certain that they all confine their attention to Orthoptera, each, of course, having its special choice.

The first we will deal with is the yellow-winged Sphex (*Sphex flavipennis*), a hunter of crickets. This means we come to our first subdivision:

I

Cricket Hunters

There is a house cricket and a field cricket and both love heat, but the house cricket loves it to an incredible degree. He is still to be heard chirping from the fireplaces of old country houses and cottages but he is growing rare. Some of the cracks he gets into are just next to the fire, and as the fire gets hotter one thinks that that is the end of him. This may please one or not according to one's like or dislike of chirps in one's house ; but in any case one pities the cricket his painful death. And then, when the heat from the fire causes one to draw one's chair right away, there comes a long contented note from his violin. On the whole, the fireplace is not really hot enough for him; the place he prefers, if he can get it, is a bakery in a burrow about an inch from the ovens and he is occasionally to be found inside a loaf of bread when we cut it open. And I feel sure it was suffocation and not the baking that killed him.

His cousin of the fields is a larger and darker and hardier fellow. He too loves heat, though he does not get much of it in England. It is the field cricket with whom we and the hunting wasps are concerned, and a rough sketch of his life might not come amiss. We will dismiss as too harrowing his early days when, issuing from the egg with his brothers and sisters, he finds himself one of the central figures of a bloody massacre conducted by ants and many others. Five per cent only escape, and our friend, of course, is one of these. Growing older and bigger—and it is growing bigger that is important—he journeys about the countryside, chirping every now and then and finding great comfort in it. A wandering minstrel, he. Becoming older he decides to give up his roving life and settle down and study music. So he makes him a house by digging a hole in some sunny bank, a simple house with a porch outside and a bachelor bedroom inside. And when the weather is warm he sits in his porch and for hours at a time plays his violin. It is a sweet song he plays with none of the harshness of the grasshopper's or the piercing shrillness of the cicada's, and he is often kept in cages for the sake of it, though some prefer songs less monotonous and consisting of a few more notes than one. This is the happiest time of his life; he is absorbed in his music, and now that he has built his house he is comparatively safe from enemies. And his life would continue to be happy for a long time, were there no Eves in the garden. But females were born as well as males and unfortunately for him some of the females also escaped the massacre of the innocents. And one of them has built *her*self a house with a porch not very far away from his. Then one day this female sitting in her porch stiffens as, borne on the still air, the throbbing notes of a violin come to her ears. The sound thrills her to the core.

A certain lady once said to me that she was not impressed by men. Virility, good looks, even the gift of talking, she said, left her cold, but when a man with a good voice sang, she was "at his feet." The female cricket feels the same way, and the notes she has just heard draw her like a magnet. So while the cricket sits fiddling, thinking only of his art, a female appears before him. He is disconcerted and shy and she is shy too, but timidly their antennae touch. After that they sit for hours fondling one another and then, after a last caress, the female goes away. But she returns, or he goes to her, and henceforward the affair proceeds with gathering tempo until they find themselves in each other's arms so to speak and the union takes place.

When he has recovered a little from the exhaustion caused by these nuptials, he scrapes a gentle note on the Stradivarius. Alas, the tune that once so thrilled the bride leaves her cold now. Indeed, it irritates her, and irritates her so much that she springs at him and smashes his violin. If he is wise he will not prolong the honeymoon. Nothing is more obvious than that his newly-wed wife has conceived a violent aversion for him. Her transient love of music too has gone. He has done the only thing that interests her and she has no further use for him. He will get more than his violin broken if he stays. He will lose arms and legs and, it may be, life. So he creeps away—a broken cricket, and in a week or less dies, for he seems unable to find his home and has not the spirit to make another and some preying thing soon snaps him up. Had no female entered his life he would have lived on for months, as is shown by those kept in cages who endure a serene existence of great longevity, chirping happily the while.

Do not suppose that the male cricket is a ninny. Before marriage he fights male rivals. They bite each other and wrestle and roll over on the ground in a very spectacular way. It is all "clean" and no injury seems to be sustained by either party. In the end one runs off and the victor sounds a triumphant note on his instrument. Once, in Kiukiang on the Yangtse, I saw a little crowd of coolies gathered round in a circle intent on something taking place in the centre. With difficulty I peered over their shoulders and saw two insects that at the moment did not appear to be doing anything very much. I did not stay but I heard afterwards that they were crickets kept for fighting and that had I looked more closely I would have seen many more in little cages awaiting their turn. Judging by the intensity of the spectators considerable bets had been laid.

So the cricket, though not possessing the powerful and wicked bite of the grasshopper, can hardly be a creature for the frailer Sphex to take on lightly. Let us review the task that confronts her. She has a sting, but she cannot use it haphazard; the surgeon does not pursue his patient through the wards slashing blindly at him with the hypodermic syringe. She has to hold him down and get him in position, and those raking hind legs are potent instruments both for escape and mischief. The rat-trap of a mouth too can give a sufficiently nasty bite—quite enough to do her business and divide her into two portions. Cerceris with her beetle had a difficult proposition, but there were two points in her favour; that ironclad was no fighter and possessed no weapons of offence, relying, with justice, on his armour, and secondly, as I have said, the nerve ganglia were situated in one spot. The principal nerve ganglia of the cricket are in three quite separate places and an injection must be made into each one of them.

Sphex flavipennis, like many of the solitary wasps, lives in a small colony. There are a number of holes in the ground—fifteen perhaps—from which issue little spurts of dust from busy shovellers within, or which enframe yellow faces looking out and studying with considerable interest their neighbours' progress. The holes lead to nests, not large ones, which, when completed, will contain two or three chambers, each chamber the nursery for one child and each of a size to accommodate four crickets. All these ladies have husbands—they would not be so busy else—but the husbands are away, wandering around as a matter of fact and finding out where the best nectar is on tap, as males sometimes do in other spheres. The children that are partly theirs interest them not one jot, and the laborious preparations for their arrival interest them less. One could excuse this if only they would lend a hand at the fighting. They are unarmed, I know, but they could be of great assistance in holding down the animals that their wives wish to slaughter; but they would shudder at the bare idea.

For a long time—over a month—the wife was just such another loafer as the husband, but now she has put that aside and is digging and shovelling as if her life depended on it. Cascades of earth are coming out such as a Scottie sends from a rabbit hole, and similar cascades are coming out from all around. She works to such effect that, provided the weather is hot and sunny, the nest will be completed in one day. The digging acts as a kind of preliminary training for the fight. She rests that night and the following day girds up her loins and sallies forth intent on doing a bit of no good to some cricket. Probably she meets grasshoppers and locusts in numbers. This always happens with big game hunters; they meet every kind of game except the sort they want. Sooner or later, however, she sees a cricket.

To follow her after she has taken to the air is obviously impossible, but Fabre has practised his sleight of hand trick. He waited near a nest until he saw a Sphex returning with her prey. At such times Sphex, alarmed by the weight of her load, generally gets a foreboding that her entrance porch will not be large enough. Always impulsive, she drops the carcass and rushes home. An inspection satisfies her that all is well and she goes back to her booty, in panic this time, and not without reason, that something may have happened to *it*. She seizes the haulage ropes conveniently supplied by the cricket's long antennae and, like a man pulling a sleigh, resumes her way. But again doubt comes. Though the entrance was large enough, what about the passageway and the room? The ropes are dropped and once more she streaks off home. Five such trips may be made to ensure that the nursery will be ready and after each trip the carcass is brought nearer the nest until at last it rests at the front door. Why she could not have got it there in the first instance and then made her inspection I do not know; probably it is because she is so excited. I have seen women much the same when a prized piece of furniture is coming out of the removal van; rushing to it, then back to the room to make sure there is enough space, back to the removal men staggering under their heavy burden to tell them to be careful, back to the house to prop open a door or move a small table still further aside. And so on. All fuss and dither, and the Sphex is just the same.

It was at such a time as this that Fabre made his substitution. Sphex had left her cricket on one of her many inspections, and Fabre had fresh, newly caught crickets in a box. He took away the motionless paralysed one and put an active one in its place, and had hardly done so when the wasp came running back. Quite why the new cricket did not seize its opportunity and go while the going was good is hard to understand. Perhaps he saw no reason for such a course. If so, he changed his mind when the wasp arrived, for he gave a terrific leap and made off at full speed. This must have come as a great surprise to the wasp. She had left a cricket whom she knew she had dealt with adequately. A butcher seeing a carcass he was about to cut up get up and proceed at full speed down the street would have had a similar shock. Surprise, however, did not prevent the Sphex going in pursuit nor, after a chase, in catching the escapist. What happened was, for a time, impossible to sort out. The close observer who was present can only tell us that there was a mix-up, first one being on top and then the other, but at last the wasp got the cricket on his back and held him down in that position. Facing the other way she stood over him, grasping the tip of his abdomen between her jaws and pressing his heaving sides between her middle legs. With her forelegs she pinioned the dangerous spurred thighs and with her hind legs she forced back the chin, keeping the snapping mandibles at a distance and prizing open the joint in the neck. Evidently she had it all mapped out: the grip on the hinder end and the pressure on his sides kept the cricket down. The hold with her two forelegs prevented the thighs from raking the operator, and the two hind legs pressing back the chin put out of reach the mouth which, had it been able to reach her, would have torn mouthfuls from her belly. Not only this, the bent-back head constituted a painful Ju-Jitsu hold and opened a vital joint. So every part of the wasp was in action except one, and that did not delay. The murderess had already loosened her stiletto and with the tip of her abdomen was feeling the neck bent ready for the operation. The knife sank in, and immediately her abdomen curved in further to a point in the chest and gave another inoculation; then further inwards still to a spot near the top of the patient's abdomen where a third stab was inflicted. These three points, so widely spaced, are in the cricket and in most of the orthoptera the three vital nerve centres that control movement.

After such careful and conscientious treatment the patient lies completely motionless. A dead cricket, one would say. Minute examination, however, will reveal a heaving abdomen, a quivering of the palpi and, at times active motions of the antennae and the hind strings. And these movements will continue for weeks. The "corpse" will also react to stimulation at any point except one of the three spots stung.

Fabre has shown us Sphex's method of killing but so far we have seen nothing of the hunting. There are two short-cuts to a kill, both very uncertain; the substitution trick and the glass bottle, but there is no short-cut to the hunt. However, those who are on the spot early and late and who keep their eyes open have lucky breaks at times. The Peckhams, as we know, were indefatigable, but I think they were also lucky—and this is just as important. A favourite cliché of Fabre's was "Fortune favours the persevering," and this is true, but of the persevering class it favours some more than others. Let us therefore go back to the Peckhams. America has many Spheges, more, I think, than are yet known, and it also has a genus very closely allied to Sphex called Chlorian. Chlorian is a large handsome wasp with a long thread-like waist: her thorax and her abdomen indeed are so far apart that they often look like two separate insects facing in opposite directions. The Peckhams were doing nothing in particular. They had rowed over to an island and were looking around when they saw a *Chlorion coeruleum* coming down a hill dragging a cricket. Chlorion is a nice name and most of these huntresses have nice figures but *Chlorion coeruleum* looks superb in her dress of shining blue. Like Sphex, she is indifferent to an audience. You can look on, she seems to say, but don't get in my way for I have work to do even if you haven't. So the Peckhams were able to follow closely on her heels like children following a small labourer with a barrow.

She made her way down the hill, through the tall grass, cricket behind, for about twenty-five feet, and then came to her nest and took the cricket in. There was nothing here of the indecision of Sphex; she was an altogether more determined creature. Having stored her game she reappeared at the entrance and sat down to take a rest and to admire the view. Then she stiffened. A long drawn note had floated to her ears.

A cricket had decided to chirp, and never has violinist tuned up at a more inopportune moment. There are times to play on a violin and times not to. But no guardian angel gave the cricket a sharp nudge or warning hiss and the chirp continued. Chlorion was as moved by the tune as the cricket's wife before marriage, but for a different reason. She trembled with excitement, and getting up moved slowly from her nest. She went into the grass, flew on to a stump, stayed there listening, then dropped to the ground again. She was on the trail and without a doubt following the chirruping to its source. This is interesting, for there are few records of hunting wasps being guided to their quarry by sound. No sound could have come from the grey worms that Fabre's Ammophila "pointed." There seemed nothing then to indicate that there was anything under the ground at all. Probably it was a sense of scent, for some insects, particularly moths, have this developed to an extraordinary degree—at least they are presumed to be actuated by this sense though there is some doubt about it.

Chlorion was cleverer by far than I am. This may not be saying much, but she was cleverer than a number of other people too. For I have followed the sound of the cicada in order to see the insect, and I have got right *on* the sound. And then what had appeared to come from just below would seem to come from above, or from in front and as I advanced the sound would come from behind and as I went back it would be on my right, though when I went to the right it would come distinctly from the left. In short, the cicada is a ventriloquist, and the cricket is the same.

Chlorion was now perched on a tall grass from which she dropped down and ran into a hole. What happened in that hole will never be known, but when she reappeared she was dragging behind her the body of a very limp musician. Apparently, on viewing it in the light she found it none too clean, for she put it down and scraped it carefully from head to foot with her mandibles, not once but several times. Then she pulled it along towards her home but before getting there stopped and scrutinized it again. Its condition still did not satisfy her and she gave it another and even more thorough scrubbing. Only then was it deemed fit to be taken into the nursery. It is very right that mothers should be careful.

The Peckhams had quite a good day's ferreting with this wasp. She hunted all the time on foot so they had no difficulty in following her. Her method was to run about poking her head into every hole she found and, if an occupant was within, descend to deal with it. When brought forth the cricket was usually in a very dealt-with condition though on one occasion further treatment was thought necessary on the way home. Perhaps it had exhibited a certain liveliness, so the back of its neck was crunched. Only one cricket eluded her in the hole and that one came out like a flushed rabbit. Had it kept on like this it might have got away, but it must needs pull up and hide itself in a leafy little thicket. Now one's only chance with a hunting wasp, if one is on its baby's menu, is to put large tracks of territory between oneself and it in the shortest possible time. Vegetation will not help, any more than the sand helps the ostrich after it has put its head in it and is smiling at the thought of its baffled pursuers. The first place the wasp went to was the thicket and a violent commotion took place. It was all—note the difficulties of naturalists—hidden from the Peckhams. What they saw was a still form dragged out later by the blue murderess. In all, they saw Chlorion capture sixteen crickets that day, sufficient to provision four cells.

After her cells have been provisioned and sealed up the cricket huntress goes back to her blameless life amongst the flowers. She has about a month longer to live. Her blood-stained knife is sheathed for ever. The crickets can chirrup to their heart's content: she will not trouble them.

Meanwhile in each of the pockets in each of her burrows a child of hers emerges from the egg and eats into the breast of the live cricket on which it reposes. After scraping it out until nothing but the shell remains it comes out by the original entrance hole and tackles the next cricket, which lies ready waiting. This time it starts on the abdomen, the best and juiciest part—and so on to the fourth. And all the time it grows with amazing rapidity and its appetite—or rather its power of absorption, for its appetite is never in question—grows in proportion. So big does it become and so eager for its food that the last cricket is eaten in a few hours. Since it never passes any faeces, by the time it goes to sleep it is swollen with the entire contents of four crickets. No wonder that in after life it never wants to look at meat again! It takes it ten days to consume the crickets and then it spins its waterproof cocoon and sinks into that strange state that is neither sleep nor life nor death and emerges after many months into the same warm weather that saw it retire. So the hunting wasps, lucky creatures, with one exception never see a winter or feel the cold. Just a small nip, perhaps, on a slightly chilly evening in September—that is all. That first chill is their cue. It is time to die.

There are many things to admire in the care and trouble the Sphex—and others—take to prepare and store their babies' food, but nothing is more remarkable than the knowledge they have of the exact amount necessary. Those whose prey is small lay in a correspondingly larger number: others, who provide large carcasses, store only one. In every case it is just right. Too little, and the grub would starve, too much and by next summer putrefying bodies would have poisoned the nursery. If you present an extra cricket to the larva just after it has so avidly consumed the last, it will not look at it. In one respect, however, the wasp slips up. Its bad subject is arithmetic. So if it has provided, say, two crickets and you take one away, it will provide two more, leaving three in all, and its baby will not survive.

Latter, commenting on the fact that most hunting wasps (not all by any means) never see their offspring after it has emerged from the egg, says, "Maternal instincts have reached no great development here." Well, I don't know. I have heard of mothers who go to much less pains and trouble and hard work for their children than the hunting wasps. One really cannot cast aspersions at a mother who, entirely forsaking her own pleasures, provides fully in every conceivable way for every need of her offspring from birth until it is adult. There are human mothers who do not go so far.

II

Grasshopper Hunters

The grasshopper is almost the largest kill that the hunting wasps make and the infant ration, therefore, is usually one. I think that all the grasshopper hunters are like this. They make a burrow which contains three or four pockets and in each pocket is deposited one grasshopper and one egg. There are several species of grasshoppers and though they vary in size and habits it will be more convenient to lump them together. They, too, are musicians—or rather the males are—but their note is shriller than that of the cricket. There will be no tales here of a wasp tracking her quarry by sound; the grasshopper hunting Sphex kills females only and the male is safe from her needle. Apparently this is because the female is larger and has a swollen juicy stomach, an altogether more appetising dish than the leathery male. The female grasshopper is also a music lover and when that piercing note comes to her ears she looks up the performer. Her ears incidentally are at the base of her abdomen or in her forearms according to her species. The latter seems to me quite a good arrangement; to catch some sound you move your arm about, and it has a much wider field than the head. And I can see the idea of having ears at the rear, if, like the grasshopper one is often pursued. What surprises me is that nature, usually so hide-bound and conventional, has had the imagination to put ears anywhere else than on the side of the head.

I dealt with the cricket's romance and told the sad tale of how a loving sweetheart changed into a virago after marriage; so it would not be right to ignore the love story of the green grasshopper, though it is rather similar. In the sex affairs of the insects we must be prepared for a reversal of the usual roles. This is particularly so with grasshoppers: the big, powerful, lustful partner carrying a large sword beneath her belly is the female; the shrinking, frightened one, the male. She visits him, and they stand face to face, their antennae touching. Not a movement comes from her save for the gentle caresses of her antennae, but he shifts about and scratches his legs and at times seems to be contemplating flight. And then, after not too long an interval, she goes away. She is back again next day, and the next, and the same performance takes place. It seems very harmless, in fact idyllic ; the sort of courtship on which the primmest observer of the conventions might smile—a mere holding of hands. Some, in fact, having in mind the future of the race, might call it *too* decorous. Let such not worry. The intentions of the female are far from honourable. These manœuvres are but the prelude to the rape on which she has set her mind. All seducers bide their time. She visits him once more and again restrains herself, still fearing that precipitate action might cause flight and bring her designs to naught. But sooner or later the assault is made, and the patient observer sees the male flat on the ground on his back, the broad form of the ravisher standing high over him with her sabre pointed downwards. Sometimes he struggles and escapes, and if he does he makes off at full speed.

The rape is accomplished with brutal lustfulness. She rudely forces open his wing casings and bites his belly; it is a kind of lecherous caress, but one which may develop in her frenzy into attack and a gaping hole in his entrails. Her desires are not satisfied until he has yielded her, in a great sealed package, all that he possesses. She leaves him then, and the ravished form lies motionless on the ground. In about five minutes, however, he gets limply to his feet and lurches off, and in quarter of an hour, if he has found something to eat, the violin sounds again. It is a weak and tremulous note, but it is the same tune, for he knows no other. In a day, always supposing that nourishment is available, he will be playing as loudly and apparently as cheerfully as before and would seem to have recovered from his rough handling. But it is a different grasshopper, really; a used-up grasshopper. Women no longer interest him. Should a female by chance come near and feel him with her antennae she gets no response and the shrunken form promises no entertainment, so she goes away.

Meanwhile his buxom wife is in the vicinity laying her eggs. Unlike the wife cricket she does not, as a rule, bother to make her husband's life a misery for him. Perhaps she realises it is sufficiently so already. She ignores him. In a week his song becomes less frequent and more pianissimo, and shortly afterwards it ceases. What is worse, he refuses food. And so to bed: he seeks some sheltered spot, flops down asprawl, and dies.

That stout matron, his wife, should she be near, now pays him her first attentions since the rape; she eats a portion of him, should any be tempting enough, or takes a leg away. And in doing this she is quite a good wife, for she has at least waited until he is dead.

So far, all the huntresses we have seen make their burrows first and then go off hunting. Hunting is a chancy business; that is why it is so fascinating. You may stumble on some unfortunate creature straight off or you may have to travel long and far. Travelling a long way to get game means travelling an equal distance to get back, and if the game is big and heavy the journey home is tiring and takes a long time. So most of the grasshopper hunters have adopted the plan of making their bag first and digging the nursery afterwards at the nearest suitable spot. The scheme has its disadvantages; it means leaving the meat lying about for longish periods, and when the huntress returns she must often find it gone, or covered with ants which amounts to the same thing. But I suppose she has weighed the pros and cons—or some ancestor has—and come to the conclusion that the other way is worse.

Sphex flavipennis, the cricket huntress, lived, if you remember, in a colony, a patch of ground honeycombed with burrows, easily found and easily studied, for if one of these wasps had brought in a corpse and you just missed it she would probably be bringing another quite soon, and if she did not oblige, some of the others would. But the grasshopper Sphex, digging where she kills, is necessarily a solitary creature and if you do find her burrow you find it only by a lucky fluke. So the observer who wishes to see a kill by using the substitution method must wait until the day he stumbles by chance on a Sphex dragging a grasshopper—or digging a hole, which means that she has left a grasshopper somewhere in the vicinity. *And* when the great day comes he must have fresh grasshoppers with him of right species and sex. Now since no naturalist, unless he *is* as mad as he is supposed to be, searches *only* for grasshopper Spheges, which he may never see in a lifetime, he ought also to have substitution bait ready for any others he may meet. Therefore, theoretically, his gear, in addition to his normal paraphernalia, ought to include a menagerie of grasshoppers, crickets, locusts, mantids, beetles, spiders, and the rest, in cages.

This presents difficulty, and it is owing to such difficulty that Fabre in his paper, *The Wisdom of Instinct*, admits that he has never witnessed the murder of a grasshopper by a Sphex. He adds that he has no dount that the Sphex drives her lancet repeatedly into the breast of the grasshopper. But that is not quite the same thing; any one could be a naturalist like that —indeed, many are. But Fabre nearly *did* see the murder once. On two or three occasions before this he had come upon a Sphex dragging her grasshopper, but it was always when he least expected it and was least ready for it and had no grasshoppers. Naturally he always tried to get a grasshopper within the narrow margin of time allowed. Never has man desired a woman as Fabre desired grasshoppers on these occasions. He rushed up and down the sacred vines, trampling on them or tearing them up in a frenzy of thwarted desire.

But no grasshoppers were forthcoming. One is hardly surprised. I am not a qualified grasshopper hunter myself, but I should imagine a slightly less Gallic approach was advisable. But he knew that the Sphex was getting nearer to its hole every second, and that the opportunity might never come again.

And then, on one never-to-be-forgotten day, Fabre, seeing a Sphex returning with her corpse, and dashing off in his usual manner to try and find a substitute, actually saw a large green grasshopper of the required species. And what is more, he caught it, and what is still more the Sphex had not yet reached home but was still wearily pulling by one antennae her huge pot-bellied victim.

Fabre seized the grasshopper from behind and pulled, but Sphex held on and struggled gamely against the extra drag. He pulled harder, but still the insect tugged at the rope, though being drawn backwards. Then Fabre took out a pair of scissors and cut the antennae. The wasp shot forward, recovered, grasped her end of the severed rope and began to pull once more, then stopped and turned round to see the reason for the sudden absence of resistance. She saw a grasshopper lying some distance behind and Fabre standing close by holding something behind his back and smiling to himself. She ran up to her prey to harness herself to it again, but on the point of doing so, stopped and stared at it. She looked at it from one side and then went round and looked at it from the other. She examined it at every point and prodded it. Then she (literally) scratched her head, plainly saying, "Well—that's not *my* grasshopper." Fabre pushed the grasshopper towards her and she looked down at it in a detached way. Then she walked off, and it was Fabre's turn to scratch his head.

The grasshopper, who all this time had seemed as if in a trance, now decided to get along. He had every point of the compass to choose from but must needs take the same course as the wasp, overtake her, barge into her, and nearly knock her over. She stepped irritably aside and looked at him, as if saying "Don't *do* that!", then hurried on. The grasshopper hurried after her. And *Sphex occitanica*, whose middle name might well be "Death to Grasshoppers" increased her pace like some young lady followed by an undesirable man. And on she went until lost to view, and she never came back. Neither did the grasshopper. Fabre of course was completely at a loss. He couldn't make it out. It was only later, after examining the nursery larder of several Spheges, that he came upon a possible solution. All the corpses in the burrows were female grasshoppers: his had been a male.

And now you must listen carefully to this, because it is dramatic. It is twenty years later and Fabre is in his study. The MS about hunting wasps, including *The Wisdom of Instinct*, is in the printers' hands and he is engaged on other work. Suddenly he hears his son Jules's voice outside: "Father, come quick! There's a Sphex dragging her prey under the plane-trees outside the door of the yard!"

Soon not only Fabre but his whole family were forming a circle round a Sphex that was dragging by its antennae a large grasshopper. The family were delighted: it was good entertainment, something unique, something they were glad they had not missed—all except Fabre, and that poor man groaned bitterly. It was the same old story; he had no grasshoppers. It was, in fact, a worse story, for he knew there were no grasshoppers in his garden or anywhere near and that it would be useless to look for any. So he cried aloud in his grief: "If *only* I had a grasshopper!"

His son looked up.

In this world as a rule virtue is its own reward, and so is kindness. No dividends are attached. This was an exception. Some time previously Fabre had come upon a nest dislodged from a tree in a gale and lying on the ground. In the nest were four baby lesser grey shrikes; three were dead, but one was living—just. Fabre took it in and warmed it and looked after it, and then turned it over to his son to care for, telling his son what insects to give it to eat. His son obeyed and took an interest in the job, but soon found his young charge's appetite difficult to cope with. So he served it larger and larger insects, finishing up with grasshoppers—the large variety of the species this Sphex dealt with.

"Father," he said. "I have plenty—caught this morning."

He dashed indoors and was soon back with three large grasshoppers of the correct species and in excellent condition. Two were females and one a male.

One can imagine the Gallic excitement of Fabre, the importance, the fussiness. He made the circle stand back, then he commenced operations (how lucky that he and his large audience had not the shy Cerceris to deal with). Evidently this Sphex did not hang on so tightly as his last, for he merely says in his graphic present tense, "I take away the prey with a pair of pincers."

The wasp turned round to demand an explanation. The circle stood and stared. The substitution had been made dexterously and what the irritated Sphex saw was Fabre's grasshopper, or rather his son's, squatting there—a fat female, too obese even to try to get away. Fabre, I think we may reasonably assume, is now gnawing his knuckles. Will it work this time? Was his last offer of twenty years ago to another Sphex refused on account of sex? Or had he got hold of the wrong idea altogether? Would this wasp, too, sniff at the mountainous form and walk away?

Pausing only to stamp her feet with vexation, the Sphex ran up. It was all right. Without a hint of hesitation she gripped the creature by the corsage and mounted it. The fat female was as docile as a sheep is supposed to be when in the slaughter house. The Sphex's flexible abdomen curved under the breast feeling with deliberation for the correct spot. No doubt it found it and no doubt it struck, and struck again, but Fabre never knew. He never saw it. The swollen body was too close to the ground, and he rightly thought it inadvisable to lift it up and see what was going on. There is a limit even to the patience of a Sphex. The wasp now forced open the grasshopper's neck by pressing on the nape, and struck again.

The thing was done. The grasshopper was inert, and Fabre took it away and gave the Sphex his second female. One might have expected some protest. She had already slaughtered two, and now she was asked to kill a third; but she obligingly did it all over again for her thrilled audience, though it must have surprised her how quickly her patients seemed to recover.

After treatment Fabre took this one away also and gave the Sphex his third, which was the male. She refused to have anything to do with it, and, poor soul, ran anxiously about looking for her lost booty. Finally she flew away and I expect dealt with her next victim in a very thorough manner in order to have no more mysterious recoveries.

So here was Fabre with three stabbed females, and I must admit he put them to good use. First of all, of course, he examined them. The legs were completely paralysed, but the belly pulsed and the mouth opened and shut. They were sensitive to pain, for at the least prick the body shuddered.

His first experiment needed live fresh grasshoppers. He caught two and kept them imprisoned without food. They died of starvation, one in four, the other in five days. Meanwhile one of the paralysed trio was kept in the dark fasting. Her antennae waved ceaselessly for eighteen days, when she died. So the surgical operations of the Sphex resulted in her prey living four times as long as it would have done without her ministrations. This seems strange, but presumably the reason is that a paralysed subject expends less energy than a normal subject, and so conserves its fuel.

That leaves Fabre with two stung female grasshoppers. His dealings with them seem to me rather horrible, but our humanitarian instincts are not really outraged by the sufferings of insects. Had these been dogs or cats we should have risen in our wrath. Yet what he did, on the face of it, was kind. He fed them. What is horrible, really, is that these motionless forms, destined normally to be nibbled by slow degrees, *could* eat. Yet they loved their food.

Fabre himself never thought it would be possible. One cannot surely, he thought, *feed* inanimate things that only differ from corpses in that they do not decay. He turned them on their backs and as they lay there rigid and stiff gave them sugar and water with a straw. Each drop was swallowed with obvious satisfaction, and the doses were continued until they were refused. They were fed twice a day. Now the grasshopper lives normally on green stuff or meat. Sugar and water is no food for them. So it is impossible to say how long they would have lived on a normal diet. Yet on sugar and water only, one (which, incidentally, was injured) lived for 21 days and the other for forty days. These experiments proved the skill of the operations of the hunting wasps.

It seems to be generally agreed by observers that the grasshopper Sphex does not reduce her victims to the same state of paralysis that most of the other surgeons do. The cricket for instance is very thoroughly dealt with and is as quiet in the nursery as the most anxious mother could wish. And this is attributed to the fact that the grasshopper operator stores only one body per infant per cell. The egg, and therefore the emerging grub, is always deposited on that part of the grasshopper that is safest, the most unlikely to give any tremors or convulsive movements. With a single large grasshopper the grub gnaws its way inside, and there it is, like a child in a sweet-shop. When it emerges it is no longer delicate, but full-grown and strong—and in any case the grasshopper is dead. But with other living bodies close by the case is different; the fragile, legless grub is in the midst of possible disaster; the twitch of a neighbouring leg, the closure of a nearby jaw and there is an immediate increase of one in hunting wasp infant mortality statistics. So it is important that when other bodies are present these bodies should be treated so that they keep still. There is another reason why the grasshopper hunter should err on the side of leniency, for were that large body to die and putrefy it would kill the grub. The Peckhams saw larvae actually eat dead (but not high and not large) game, but they also saw a lot of the larvae die. Certain wasps—the bee-hunters for instance—do store up dead meat, but bees, like flies, "keep"; they shrivel up instead of putrefying, in the manner of sun-dried fish. The Peckhams have commented on the fact that hunting wasp babies presented with dead bodies eat them and have rather hinted (ignoring the fact that many died) that the elaborate surgical operations of the mother were therefore unnecessary. Personally I do not think that the wasp parent goes to all this trouble just for fun, and anyway even a human child would eat ice-cream plentifully besprinkled with arsenic. Probably wasp children, like human children, eat what comes without putting it to tests. We always deny intelligence to other creatures yet at the same time expect them to have much more of it than *we* have. So I think that with wasps, as with ourselves, we may assume that "mother knows best."

Having paralysed the grasshopper the Sphex goes off to make a home for it. This home will be as close as possible, but she cannot dig it just anywhere. It must be dug in material of the right consistency; pockets of sand between stones or even decaying mortar in the eaves of a roof, and the quest may lead her some little distance from her bag. Having found the right spot she digs the nursery, singing a song the while. Then she goes back for her game and if she finds it harnesses herself to its antennae and takes the strain. The heavy load goes lumbering behind. Sometimes she uses her wings, not to fly with but to give extra power like a taxying aeroplane. The journey is nearly always made entirely on foot.

We have mentioned the brain treatment meted out by other wasps to recalcitrant corpses. With no game is this treatment more necessary than with the not-too-well-stung grasshopper. Though it cannot use its legs for jumping during the journey home, it can use them to clutch at blades of grass with the barbed forearms. Its jaws, too, can operate as well as ever and can hold on to obstacles, or chew pieces out of the straining hindquarters of the Sphex herself if chance offers. This has to be attended to, so she turns the creature over and once more gets astride its broad back. The usual compressing of the base of the skull takes place until no movement at all remains and consciousness has gone. The process is not unlike sandbagging in its effects. In a couple of hours the subject will recover, but by then it will be safely installed in the nursery.

The journey to the nest need not detain us. It is very similar to that of the cricket Sphex, with the same frequent trips to see that all is in order at home and to effect repairs and alterations if necessary. When the nest is at the top of a house or wall the spectator will probably get plenty of amusement. She climbs up the perpendicular face hanging on to any inequality or small crevice and pulls her great load after her. Edward Whymper might have studied her with profit. But progress is slow. It is when she reaches the top that the mishap usually occurs, for another of those famous last minute inspections will almost certainly be made and to do this the grasshopper must be deposited. It is usually deposited on the edge of some tile or any place from which it will inevitably fall. So when the Sphex turns her back it topples over and lands on the ground at the starting place of the ascent. However, the Sphex goes down, finds it, and the two, roped together, make the climb once more. At the summit, ten to one, she puts it in the same place, and again it disappears over the edge and Sphex stares sadly down after it. This may happen several times, but Sphex is no quitter and at last learns sense—or luck favours her—and she gets it inside.

The Peckhams studied an American wasp, *Sphex ichneumonea*, which is also a grasshopper hunter, and from their account this species would appear to dig its nursery first and then hunt its prey, though the length of time it took to find one—about a couple of days—probably indicates that it waits until it comes upon one close by. They witnessed no killing, but saw it bring in a grasshopper. They dug the grasshopper up just after it had been interred and their examination of it is not without interest, though containing nothing new. The egg was deposited in the usual place, the abdomen was beating regularly and automatically, but there were no other movements and no parts responded in the slightest degree to pricks or electrical stimulation. A little later the antennae began to move, and the next morning the grasshopper was "very lively." "Very lively" is not exactly the term I would have used myself. At any rate, if any friend of mine is "very lively" when in the condition of that grasshopper I hope to goodness he never gets depressed. It had passed faeces, the antennae and the lips moved, and it was able to lift its abdomen and curve it towards its head. This seems to be a typical example of a grasshopper that had been sand-bagged on the journey. It arrived completely inert, and gradually got—lively; stunned for the purpose of safe haulage, but only temporarily.

On the next afternoon its condition was the same, but the egg was dead. I should think the egg had probably been damaged in the digging up; it was a piece of luck unlikely to happen to a grasshopper normally and when underground. Perhaps the grasshopper also had been damaged in the digging up for it began to lose all its *joie-de-vivre* and on the fifth day it died.

III

Locust and Cockroach Hunters

In its home in Northern Scandinavia you will not often see that small guinea-pig-like animal, the Lemming. The London Zoo can get most things, but it has no Lemmings, much as it desires some. Admittedly this is chiefly because the Lemming dislikes captivity and shows it pointedly by dying, but even in its native haunts it is not to be seen every day; one here, one there—like woodcock. Yet these are the animals that at certain intervals combine to form a vast army, and march westwards. During the whole of that march they are massacred day and night by congregations of foxes, stoats, birds and others and shoals of fish pull them down as they swim the rivers and fiords. Yet such are their numbers that all these hazards, and many more, make no difference to them; the overwhelming army rolls on, invincible solely by reason of numbers. Then comes the sea, and without hesitation they go straight into it. Perhaps at one time in the world's history there was only a narrow arm where the North Sea now stretches. If so, they would have been well advised to keep more in touch with recent events. Indeed, there is no doubt that this apparently suicidal march originated in remote times when the map of the world was different, continents stretching where seas lie now, and when this mass migration would take at least *some* survivors into new territory. But now, having entered the sea, they are never seen again except occasionally by steamers who plough through their massed swimming ranks often for quarter of an hour or more. After that, as a race, they resume their normal role as a rather rare little mammal of the north.

The locust behaves in much the same way. You may spend a large portion of your life in its haunts and come away having seen only one or two. And those will have impressed you favourably, eating only the coarser herbage shunned by cattle and paying little attention to cultivated fields. I myself went to Africa when young and must confess to faint disappointment (not being a farmer) at the entire absence of those flying clouds of locusts, darkening the sun, about which I had read so much, that left the earth like a billiard table without its green baize cloth. For I had had a vague idea that these visitations were more or less of yearly occurrence and I had conceived a great admiration for the courage of the farmers who sowed crops that were almost certain to be devoured, not pausing to consider this would not have been courage but lunacy. But all I saw during my sojourn of many years was an occasional locust behaving in an orderly fashion and attending strictly to its own affairs. So I returned from that country with good opinions of locusts and scepticism as to their destructiveness. Visitors to Germany before 1914 and 1939 returned with much the same opinion of the inhabitants.

Perhaps amongst locusts too arises from time to time a dictator who encourages intensive breeding, for now and then, from unknown breeding grounds, come such hordes of these creatures that all our most recent A-L batteries are unable to check their advance. Moreover that quiet, unassuming personality changes to arrogance as they pillage and lay waste the territories they occupy. "And when it was morning," runs the description in the Bible, "the east wind brought the locusts. And the locusts went up over all the land of Egypt. They covered the face of the whole earth so that the land was darkened, and they did eat every herb of the land, and all the fruit of the trees, and there remained not any green thing in the trees, or in the herbs of the field throughout the land of Egypt."

The first attack is the worst, and it is made, strangely enough, not by seasoned troops but by raw youngsters. These wingless "hoppers," tumbling and squirming together but rolling steadily on, engulf the country like a wall of molten lava from an erupting volcano, and with similar results to vegetation. In later stages—in those famous flights that darken the sun—they are not quite so bad. The areas on which they settle are laid waste, but the country they fly over is not. The farmer, seeing them coming and hearing the sound of their wings like a gale passing through the rigging of a ship may well tremble in his boots as for three hours or so they pass overhead. He is in a similar position to Londoners in the days of the flying bombs. *They* heard that pest coming and getting nearer and nearer, and waited, shrinking, for its engine to stop, the sign that it intended to descend. And as it passed overhead they heaved a sigh of relief. They knew that somebody else would suffer further on and it was wrong, I suppose, to heave that sigh at all. But they did. And so does the African farmer, though he too knows that somebody else is going to get a very nasty packet further on.

All this refers to the migratory locust. There are six other species in Africa and several more in Europe, and I could not possibly say how many in America or in the East. Sphex again figures prominently in the Anti-Locust campaign, but the red and black (or sometimes white and black) colours of Tachytes (The Swift One) are never far behind. Indeed, where the one is you will see the other, whether it be in a skirmish against crickets and grasshoppers or an affray with locusts. In only one engagement do we find an absentee, and that is the fight against that ogre the Praying Mantis.

But there is such a thing as too much murder, and the methods of Sphex and Tachytes with locusts are the same as the methods of their other species with crickets and grasshoppers. There is no object then in studying what we have seen before, so I will pass on to another scourge—though I would sooner remain with the locusts.

The flat, obscene cockroach with its nauseating smell that squeezes horribly into narrow crevices is—to me—something straight from a nightmare. On hotter seas than ours steamers are riddled with them. They come out at night in unspeakable slithering masses and eat the refuse and get in bunks and nibble toe-nails and hair. Cockroaches and rats: can you have a fouler combination? I am prejudiced against them I know—if one *can* be "prejudiced" against what is entirely vile. I am prejudiced because I have travelled in dirty steamers in the tropics and China and because I have slept in filthy Chinese inns where—with the rats—cockroaches made night a purgatory. And I am prejudiced because of something else. I had known that cockroaches nibbled at one's nails and hair, but I did not know this other thing. The story is not for the weak-stomached. I was in the Rhodesian Police at an up-country outstation, alone except for a force of Native Constables. Murders at native kraals were fairly frequent; probably very frequent, for I am sure that not more than 10 per cent were reported to me, for which I was grateful, having quite enough to do already. One morning the relatives of a native living at a kraal twenty miles away came to my office and reported that this native had died in great pain after being perfectly fit before he took his evening meal. I went over, riding on a mule which was the only transport then. The native was dead, and by his expression death had not been kind. Usually, in these cases, nobody knows anything, but this time questioning brought to light the fact that he had an enemy, and a vindictive one, who many times had announced his intention to do things to him, the reason (*cherchez*, of course, *la femme*) being a wife who had transferred her affections.

In those days poison was easy to come by. At almost any farm strychnine to poison jackals, leopards or what not could be found in a paper bag on some shelf like so much sugar. In fact, on a patrol, I once visited an isolated storekeeper and passed the night with him. I had run rather out of provisions and in the morning he replenished my small needs. He got the tea and some flour and was going to tip out some salt from one of a number of tins on a shelf when he stopped, looked at it, and said, "No, my gosh, that's the strychnine." I did not join in his hearty laughter at the mistake. I would have been using that "salt" very soon, and there are no doctors in the veld. Nor that one would have been required except to confirm that life was extinct, for I am very fond of salt.

Obviously, with this native, the only thing to do was to call in some medical officer and have an autopsy, for it seemed fairly certain that his enemy had poisoned him. I returned, taking the said enemy with me, and leaving two native police at the kraal. I arranged with a doctor from the nearest place, thirty miles away and he came in his buckboard to the camp with his case of instruments and bottles and off we went together. The body had been placed naked on a blanket on the floor of a hut. These huts have no windows and after the brilliance of the sun outside it was very dark within. The corpse lay there, but it shimmered and seemed to move. Then we saw what it was; it was covered with a mass of cockroaches so that no portion of it was visible. They had grown alarmed now and were leaving it, fleeing wildly, covering first the floor and then the walls, squirming into cracks and crevices and hanging in obscene knotted struggling ropes. Soon they were gone, save for the odd ones hiding here and there and dashing for safety every few minutes. We had got accustomed to the dimmer light and could see. The corpse had not the external appearance of the corpse I had first inspected. The entire skin was pitted and gnawed and corrugated like wave marked sand, and this included the scalp from which all the hair had been eaten.

That explains why cockroaches fill me not only with repulsion but with a kind of dread. For that corpse was not a pleasant one to other senses besides the eyes. Many hot days had passed since it died. And that made it necessary to do what we had to do as quickly as possible. We had it carried away into the veld and then sent the bearers back. Would I could have gone with them! but the doctor needed an assistant. It was soon over. I admire that doctor for he was closer to it than I. He cut the stomach open. The smell was not so much a smell as a physical force; a powerful heavyweight that crashed blows into you, into the heart, into the solar plexus, seeking (and nearly obtaining in my case) a knock-out. The doctor meant to cut some of the organs out and take them back for analysis, but he did not need to. As he passed the dead man's intestines like lengths of rope rapidly through his fingers, he stopped and pointed. There was a complete knot at one place, coloured green and purple. It conveyed nothing to me but the doctor said "Peritonitis" and got up and came with me to windward. There was no foul play—except by Nature and I couldn't arrest *her*. We shared a flask of brandy, and needed it.

I regret having allowed cockroaches to lead me so far from my subject. Actually there is little to say about the cockroach hunters except to wish them the best of luck. Certain Sphex species hunt them in the tropics and in Mauritius, but little about them is known as yet. Personally I think it surprising that any of these wasps should have dealings with cockroaches. The hunting wasp is so clean and so particular about what her baby eats and so horrified with anything connected with filth. The dung beetle, for instance, is avoided by any Cerceris although it possesses the ideal arrangement of nerve centres.

Cassigni witnessed the capture of a cockroach by a wasp and told Reamur about it. The wasp was out hunting. Sometimes it walked, probing here and there, and sometimes it flew, using its eyes like an eagle or hawk. It was on one of its pedestrian expeditions that it came upon a cockroach and the two stood face to face. If the timid cockroach was, as it appeared to be, paralysed with fear, then it was but a foretaste of the completer paralysis to come. The wasp seized it by the "muzzle" (wherever this is in a cockroach) and put its abdomen underneath the trembling form. What attitude it adopted; whether it mounted the beast and held it from above as do the cricket and grasshopper hunters Cassigni does not say. Nor does he say, and probably could not see, how many stings were given. The wasp soon left the cockroach and circled over it, noting the effect of the operation. Then she descended and dragged her unappetising prize by the "head" (antennae?) towards a hole in a wall close by, putting it down for a rest several times but eventually getting it there. At the threshold a hitch occurred; the cockroach would not go in, it was too big. The wasp tugged and pulled and strained, but to no purpose. She then, continues Cassigni, gave it up and came out and lopped off the wings and legs of the creature and by this means reduced its bulk sufficiently to get it into the hole. This is strange. No solitary wasps except the spider hunters lop off the limbs of their prey and the spider hunters only do it occasionally in a vague, uncertain manner. In cutting off legs and wings like this the wasp proved itself much further advanced than any known to-day. But evidently Reamur passed the story as correct.

IV

Mantid Hunters

There are more than 800 species of mantids known, but this need not occasion alarm; we are only going to deal with one, *Mantis religiosa.* Of the 800 only twenty live in Europe, and none in Britain. This need neither depress nor elate Britain, for the mantids have no quarrel with man. In a way, they are friends, very luke-warm friends, but when they are not busy torturing and eating each other they undoubtedly add a few flies and one or two harmful insects to a very catholic diet.

Concerning *Mantis religiosa*, no other insect except the bee has got itself more publicity, and no other insect at all has fooled so many people so long. It was the hero of countless legends with the Ancient Greeks and managed to persuade them that it was endowed with supernatural powers: hence its name, *μάντις*, a diviner. The Arabs still maintain that when it pray it turns its face towards Mecca; French peasants call it the *Pray-to-God*, we call it the Praying Mantis; and even stern, matter-of-fact scientists have apparently been so much deceived by it that they call it *religiosa*. It just shows what a good act it puts up and how its sanctimonious attitude impresses everyone it meets. A novice in a convent might study its stance with advantage and reap golden opinions from the Mother Superior, though it would be inadvisable for her to let her imitation of this insect go any further.

Always an actress, the Mantis, on the approach of some honest wayfarer, changes her attitude of pious meditation into that of a nightmarish spectre. So where at one moment stands a female saint from some stained glass window appears the next an apparition that turns the blood to jelly. The gauzy wings are spread out to their full extent behind, above and on either side of her, like the wings of Satan, but fuller, the long neck with the little head on top and the glaring eyes is thrust forward, and the arms, folded to her breast before, now tower bogey-like above her head.

You may smile, but if the Mantis were your own size, or larger, and you met her praying and were on the point of bending a quick knee or removing a hat according to your sex, and then saw her change into an apparition like that, *you* would be frightened. And so would I.

When a boy puts a white sheet over himself and stretches his arms up over his head and pretends to be a ghost, he strikes a similar attitude. But his act is amateurish; that of the Mantis is not. The wayfarer stands so frozen with horror that it is unable to move. Or so they say. Myself I am surprised at insects having so much imagination, but the fact remains that the average passer-by stands still and stiff. Some may try to run away at what pace their congealed blood allows, but both static and non-static are picked up by the Mantis and gathered to her bosom between those saintly arms.

Her talent for appearing first as one character and then as another is not surprising for she comes of an acting family. Most of her mantid relatives are artistes too. The various species of "walking-stick insects" imitate pieces of grass, lengths of straw and twigs with such perfection that until they move it is impossible to tell the difference, even the joints being exactly like the joints of the plant they mimic. *Hymenopus bicornis*, a Mantis of India, is sometimes white and sometimes pink. She sits on some bush or plant and arranges four of her thighs, which are broad and oval shaped, into a circle round her body, tucking away the rest of her limbs out of sight. In this posture she is *exactly* like a flower. She is so obviously a flower that bees and others, including butterflies, cruising around go straight up without question to see if this particular blossom is yielding honey. They discover too late that it is not. *Gongylus gongylodes*, another Indian Mantis, is an ordinary insect of a green colour until she turns herself upside down and exposes her underparts, which when she wants a meal she does, and hangs from some bush. Seen thus she is a lavender-violet bloom, the margins tinged with red. In the centre is a dark brown circular blotch which looks like the opening of the tube of the flower's corolla, but which of course, in reality, is merely a mark on the actress's stomach. Her limbs are violet and appear as delicate tendrils which in any breeze she waves convincingly as if they were being moved by the wind. They are far from being delicate for it is they who gather up the many who rush in.

Yes, a distinguished acting family.

And a predatory one; but the most predatory of all is our praying friend. And that any of the solitary wasps should, in cold blood, decide to hunt her, of all creatures, is surprising. Are there not caterpillars, crickets, locusts, grasshoppers enough that they must needs concentrate on this formidable animal who feasts with relish on hornets? It is as if a man with rabbits and game in abundance all around sought, when he went out to get something to eat, only grizzly bears. It is not as if the gastronomic qualities of the Praying Mantis were something out of the way or the meat possessed a flavour so piquant as to be irresistible. It *may* do so, of course, for all I know, but the huntress herself never tastes it and one can hardly suppose she studies her baby's palate to that extent. And it must be granted that not many of them *do* take on the Praying Mantis. That great orthoptera hunter, the Sphex, leaves her severely alone, and so does Tachytes, except for one member of the family, and that member a small one—not more than half an inch long.

So the Mantis stands there, apparently in a holy trance but probably licking her lips at the thought of what she is going to do to her next victim, and hears a buzzing noise. She looks up and sees a small insect coming towards her. She does not bother to put on her spectral attitude, which in any case is usually reserved for pedestrians. And if she did, it would make no difference to Tachytes, who has spotted her and is coming down to do battle with her.

This Mantis huntress is red and black with rust-coloured legs and it is evidently no surprise attack that she intends, for her buzzing has attracted attention and the Mantis is staring up at her. This Mantis is a young one, not so formidable and certainly more juicy than a hardened elder but dangerous to a degree nevertheless. Tachytes does not come straight for her; she whizzes by, then turns and flashes past again. The eyes of the Mantis follow her. The Mantis has a long neck with a face on top of it; a rather prim little face with a pointed chin, and she can turn her face in any direction without altering her position. It is a little uncanny, yet at the same time comical.

I have often passed a Praying Mantis in the open and noticed her eyes fixed on me, and when I have gone by I have looked back and seen her in the same position but with her eyes still on me, her head completely reversed. She shows no sign of perturbation at the advent of Tachytes, only a Sphinx-like stare. Indeed, she seems not greatly interested; there is no meal here—the thing can fly too fast.

Any boxer will tell you that against a powerful antagonist who packs a wicked punch the direct attack is no use at all. A crude frontal slogging match would have only one result. The thing is to dance around and keep the opponent guessing. This is what Tachytes does, and she keeps *behind* the Mantis. There she flies backwards and forwards more or less in a straight line like the motion of a piston. The Mantis does not budge but keeps her eyes on every movement, with her head, of course, slewed right round. Provided, she thinks, she keeps this lunatic under observation she will be ready for any developments. So her reversed head moves from side to side with the motions of the wasp like the head of a spectator at a tennis tournament.

The plan of Tachytes is becoming obvious; she is tiring out the Mantis whose eyes must surely be watering and whose neck must be stiff. Such vigilance under such conditions cannot be continued indefinitely. Turn your own head round to its fullest extent and follow the movements of a pendulum and see how quickly you tire! So at last the Mantis condescends to change her position and face around. It is waste of time ; at once the wasp is behind her again, continuing her oscillations.

It is beyond the power of the observer to catch the first signs of relaxation on the Mantis's part, but the wasp does, and in that instant attacks. I, and probably you also, have seen a small boy, roused to fury by a big one, get behind the big one when he was not looking and spring on to his neck, doubling his legs and arm round him and rendering the big boy momentarily helpless. This is what Tachytes does. She launches herself on the back of her enemy's neck with a movement so quick it cannot be seen, and doubles her legs round her neck and thorax. She must make haste; those dreadful arms must be put out of action in the shortest possible time after alighting. So, if her aim be true, her sting darts into the nerve headquarters that control them almost at the moment of landing. The arms of the Diviner fall limply to her sides. Never again will their teeth impale the passers by or be folded piously in prayer. Never again, if it comes to that, will they move at all.

We can almost hear the wasp's "*phew!*" of relief. She has really hardly started yet. She is in the position of those bomb disposal experts who have removed the time-fuse and can get on with the rest of their job at their leisure and in safety. She clambers down the back of her prey—and the word prey can now be used without dispute, for the Mantis is as demoralised as a gun-man whose revolver has been snatched from its holster—and at leisure stabs the Mantis between its hind legs.

That seems to be all for the moment, for Tachytes cleans herself and combs her antennae as she stands over the body. Hunting wasps are always doing that, particularly after a tussle; they remind one of ladies powdering their noses and patting their hair.

We will not follow her as she takes her booty home, for there is nothing new to be learnt. Unlike Sphex she takes the carcass straight to her nest, and straight inside when she has got there. This is admirable from her point of view, but it gives observers little chance of examining her killing methods by substituting fresh prey when she is not looking.

Fabre wrote a paper which he called *The Ignorance of Instinct.* He begins by citing three examples of the idiotic behaviour of grasshopper spheges when things did not go entirely according to plan. Fabre, as you may have realised by now, will not allow one ounce of intelligence to any insect. It is all "instinct." According to him the insect is a marionette manipulated by Instinct. Therefore he is quite consistent, and instead of calling his paper "The Silliness of Sphex" he calls it The Ignorance of Instinct.

"Instinct," like "electricity," is a very convenient word. It explains everything without explaining anything. Some celestial giant studying mankind through a lens would, I suppose, inevitably come to the conclusion that mankind was motivated by instinct—in which case he could write several more books called "The Ignorance of Instinct." That the actions of these hunting wasps *are* mainly instinctive is obvious. They have had no instruction in the difficult art of anæsthetizing nor in the selection of the necessary diet for their young. That is taken for granted and is not under discussion. It is the in-between bits that we must put our minds to. And these examples Fabre gives do not, to my mind, show up the Sphex as being silly at all. I am sure the Sphex *can* be silly, very silly indeed—so can we—but I don't think Fabre has been happy in the examples of ignorance he has selected. We must of course judge from our own view point, just as Fabre did, and assume our own reactions to be wise and uninstinctive. So in commenting on the samples of foolishness he cites I will compare them with what we might have done in more or less analogous circumstances.

His first example seems to me the most doubtful of them all. A Sphex that he saw dragging her grasshopper to her nest found a Praying Mantis in the way. I have touched on this dangerous creature before. All I need add is that normally her very appearance so freezes insects with terror that they can be picked up and eaten. And if they are not frozen with terror and are able to run falteringly away the Praying Mantis soon catches them. Well, this Sphex dragging her prey and meeting this Praying Mantis direct in her path dropped her prey and instead of being frozen with fear or running away went straight for the Praying Mantis. The Praying Mantis closed her deadly spiked forearms but failed to impale the Sphex. The Sphex went back to her booty and recommenced dragging it. The Praying Mantis was still in the way and had not budged. The Sphex made a detour round her, eyeing her menacingly. The Praying Mantis kept her large eyes on the wasp also, but apparently the fiery glance of the indomitable Sphex out-stared her, and she passed by unhurt.

And this Fabre cites as an example of the ignorance of instinct. He thinks that the Sphex ought to have known that the Praying Mantis was deadly to a degree and ought to have fled. But surely to have done so would have been fatal; the ogre would have bounded after her and caught her. She was waiting to do so. In all probability that unexpected defiance saved the Sphex's life. And later she passed by, pulling her booty and eyeing the ogre. More foolishness. But having started she had to go through with it. The puzzled Mantis was waiting for the first sign of fear or indecision.

Fabre admits the bravery but calls the rest ignorance. Actually from the moment she sighted that apparition in her path she adopted the only course possible to save her life. If this is ignorance, then Britain displayed the same ignorance in 1940. But Fabre, who was French, says the Sphex was merely stupid.

Let us go on to his next indictment—this time a more serious one. He calls it:

Experiment 1

Fabre has witnessed a Sphex hauling her prize along, as she always does, by its long antennae. He cuts these antennae off short. The wasp halts, turns round, drops the severed ropes, goes back, and seizes the little bits of antennae still remaining. And hauls again. Fabre now, with great care and his finest scissors, severs the remaining bits of antennae level with the skull. What does the wasp do now? Give it up? No. She drops the two antennae bits and grasps the grasshoppers long palpi. Heave-Ho again. By this time the wasp has brought her grasshopper to the door, and she goes in for a brief inspection. While she is doing this Fabre takes the opportunity to cut off the palpi. Not only that, he takes the grasshopper away altogether and puts it in another place three feet distant. The Sphex, as it happens, has seen this manœuvre from her threshold and comes running up indignantly. I will quote:

"The Sphex goes straight to the captive. She looks at the top of the head, she looks underneath, on either side, and finds nothing to take hold of. A desperate attempt is made; the wasp, opening wide her mandibles, tries to grab the grasshopper by the head. But the pincers have not sufficient compass to take in so large a bulk, and they slip off the round polished skull. She makes several fresh endeavours, each time without result. She is at last convinced of the uselessness of her efforts. She draws back and appears to be renouncing further attempts. One would say she was discouraged——"

I should not be surprised.

Now comes Fabre's charge. He says there were other parts she might have laid hold of, such as the legs, and, going round to the other end, the tip of the abdomen, though he admits that hauled in any such way the prey would probably have stuck in the hole. Further to complete her exposure and show her for the fool he claims her to be, he *offers* her a foot in his fingers as she sits cleaning her face like a cat, obviously having thrown her hand in. The foot refused, Fabre turns the grasshopper round and offers her its nether end. She is not interested.

Fabre does have the grace to admit that "perhaps my long presence and the unusual events that have occurred have distracted her faculties." So he leaves her, thinking that she will turn the matter over in her mind and see what he meant when he gave her first a foot and then the end of a belly. She does not, or if she does she no longer cares; she merely finishes her wash and goes away, leaving him the mutilated grasshopper to do what he likes with.

That is the indictment and the prosecution has stated its case. I will be the judge and you will be the jury. Was the Sphex stupid and ignorant, or was she not?

The Sphex was one month old, more or less. To compare her intelligence with that of a man, a creature who goes by the proud title of Sapiens, is loading the dice against her. But we will do so. And I think the nearest analogy we can get to the case in question is that of a gardener pulling a wheelbarrow. This gardener goes along pulling his wheelbarrow by—as is very right and proper—its handles. An enormous giant appears. *Homo sapiens* does not run away but continues pulling. Giant cuts off wheelbarrow handles near the base. H.S. looks round and probably—if he is the sort of gardener I know—says something. However, he takes the stumps of handles left and goes on pulling the barrow as before, but with much more difficulty. Giant comes and lops off the handles clean to their base. H. S. says something again. But he is not going to give in; he can get hold of the wheelbarrow by the corners of the frame. It is extremely difficult to pull it now but he does so and stumbles along. Then he leaves it for a moment, perhaps to get his breath back or to pick up a weed. The giant immediately cuts off the corners of the frame. In addition he takes the wheelbarrow about half a mile off. The gardener rushes after it and tries to get hold of it to pull it, but simply can't. He then looks at it and says, "Well, it's ruined anyway, and if I started pulling it by the wheel struts he'd only cut *them* off. What's the use? Let him have the darn thing, there are plenty of other wheelbarrows, and as soon as he's gone I'll get one of those." So the giant goes away and thinks that the gardener—with plenty of other wheelbarrows close by—will decide to drag this one by its wheel struts or the wheel guard or some other ridiculous place, and because he does not and goes away and gets another one he writes a paper on his ignorance.

Personally I think the Sphex behaved just as you or I would have done under similar circumstances. Indeed, if there was any foolishness it lay in her not giving up before. But Fabre sums up: " And so this rival of Flourens (a famous anatomist) who but now was startling us with her cleverness as she dexterously squeezed her victim's brains to produce lethargy, becomes incredibly helpless in the simplest case outside her usual habits."

You, the jury, will now retire and consider your verdict. Come back soon, for Fabre has another case against the Sphex.

He calls it:

Experiment 3

I must quote him again, for he gives a superb picture of the wasp closing her front door which should be carefully noted. As an observer he was indeed "incomparable."

"The wasp is engaged in closing her burrow, where the prey has been stored and the egg laid upon it. With her front tarsi she brushes the doorstep, working backward and sweeping into the entrance a stream of dust which passes under her belly and spurts behind in a parabolic spray as continuous as a liquid spray, so nimble is the sweeper in her actions. From time to time she picks out with her mandibles a few grains of sand, so many solid blocks which she inserts one by one into the mass of dust, causing it all to cake together by beating and compressing it with her forehead and mandibles. Walled up by this masonry the entrance-door soon disappears from sight."

And now Fabre starts his tricks, beginning by pushing the Sphex rudely aside. He opens the door with a penknife and carefully extracts the grasshopper with his forceps. Having done this he allows the Sphex (who all this time has been waiting beside him wondering what on earth he thought he was doing) to rush anxiously in. She stayed in some time and probably felt very put out at seeing her grasshopper—and her egg, for she had laid one on it—gone. Then she came out and —here is the whole point; this, Fabre thinks, condemns her as silly—she closed the door before she left the place for ever. And it *was* silly. It was quite unnecessary. She had seen that her grasshopper had been stolen. Then why shut the door?

Again, before condemning her, we must make quite sure that *Homo sapiens* would inevitably have acted differently. And as an example we must not take some intellectual giant such as a member of the brains trust who solves all problems immediately, including, I hope, his own, but a fussy little woman, which is what the Sphex is. And one, moreover, in a very distressed condition. When Fabre ravished the Sphex's home he did it carefully with a penknife; he did not wreck the whole place; it looked just as it always had done. Yet I myself have seen a heart-broken woman inspect the pile of rubble that was her home before the bomb fell on it and come out and carefully shut the door which was merely attached to a bit of wall, the only part of the wall left. And have not we some proverb about locking the stable door after the horse has been stolen? So can we who live in glass houses afford to throw bricks at Spheges? Or rather, can Fabre? Yet he is amazed at the stupidity of this Sphex. Her closing of the door he calls "supremely absurd." And it was. But who of you amongst the jury will find her guilty?

His next indictment is made against *Sphex albisecta*, a locust hunter. He first attacks her because, like all the Spheges, she makes a number of visits to her nursery when bringing home her prey. To drop the prey and leave it is of course subjecting it to hazards. One visit, says Fabre, to see that all is in order and that the aperture is large enough ought to be ample. Why does she make several? All this, of course, has already been dealt with in the cricket section; I will only add that a human mother without *any* reason for doubt, having arranged the nursery, often pays visits to it and makes little unnecessary adjustments here and there without anybody attacking her for it. And the Sphex *has* reason for anxiety: parasitic flies can slip into her home in a split second and she has to make very sure that none such are present when the meat is stored.

The second part of the charge is graver and there is little defence that can be made for the Sphex. There is nothing new here either; it is merely a repetition of the last experiment with the grasshopper huntress but this time the prey, a locust, was taken away when she was dragging it down. She searched frantically for it everywhere, then gave it up. But before she went off she *shut the front door.* She had not the excuse of the other Sphex. She had not stored it yet and she had not laid an egg on it. Perhaps she thought she had done all *she* could. If it wasn't in, she argued, it was Fabre's fault, not hers. Let *him* put it in—and let him lay an egg on it too. She was through.

But I don't quite know why she locked the door.

The next on the charge sheet is the cricket huntress. In her burrow there are pockets, and in each pocket are stored (or should be) four crickets, the correct quantity to sustain one baby from hatching to cocoon. But sometimes in one pocket are found only three, or it may be two, crickets—short rations for the baby. Fabre assumes, and I dare say he is right, that the reason for this occasional shortage is the Sphex habit of having several "last" looks at the nursery before bringing the food in. Ants get at the cricket while she is inspecting. Returning and seeing ants on baby's food she rightly declines it. To take it in with ants attached *would* be idiotic. She just writes it off and goes and gets another. *But*, Fabre thinks, she still counts it as one. So assuming she has stored two already she adds one more only; the whole, together with the one the ants got, making four. Apparently she does her counting when she kills them and after that goes to pieces. When she seals the pocket up the corpses are there before her. She has no fingers but surely she can count up to four in her head and by a tally discover that there are only three. This *is* stupidity, and I am afraid we must face the fact that she is no good at arithmetic. But then neither am I—and *I* went to school.

That is the end of the charges in Fabre's paper, *The Ignorance of Instinct.* Actually I think it a contradiction in terms. I don't think instinct *can* be ignorant. The ignorance came in when the wasp was not being ruled by instinct. But Fabre thinks there are no in-between bits and that everything the wasp does —like a somnambulist—is instinct. Few observers agree with this. They find these solitary wasps full of character.

It is surprising that Fabre is so rigid in his views, for he himself made an experiment that showed how differently wasps of the same species react. He did that tantalising trick of pulling the prey away just before it is taken into the nest. As we all know, the cricket wasps get their crickets to the hole ready to be pulled in and then go down for the final inspection of the chamber. In the experiment in question Fabre pulled the cricket away a few inches when the owner was down the hole. The wasp came out, saw the cricket lying in the wrong place and put it back again on the threshold. This meant, of course, that there must be another final inspection before dragging it in. During this second final inspection Fabre once more pulled the cricket away a couple of inches. Wasp emerged, fetched it back and went down for a third "last" look. Fabre again pulled the cricket away.

We have here the beginnings of perpetual motion if only both parties can keep it up; the wasp keeps on going down and Fabre keeps on taking the cricket away. It is a sort of Test Match, and Fabre tires first. This says a lot for the wasp. Fabre was no quitter. Women going to work on the vineyards in the early morning used to see his form crouched down staring at some spot on the earth. Returning in late evening they would see him still there at the same place and in the same attitude and they would cross themselves and look at each other and murmur a French word which means a harmless as opposed to a dangerous lunatic; but for all that they would increase their pace.

Fabre tried other colonies of wasps with the same result. And then—which shows how careful one should be before generalising—he came upon wasps of the same species who acted differently; who learnt in three goes to change their tactics. The same game was played with several of them, and they all fell for it. But only, in each case, three times. When Fabre, that persevering man, pulled the cricket away the fourth time they came up as usual and dragged it back but this time there was no last look; they took it straight down. They had *learnt.* Now instinct cannot learn except over periods of thousands of years, so Fabre should have realised that at least *some* solitary wasps are not all instinct.

I suggest that insects and men are motivated by a mixture of instinct (which is only habit so deep-rooted that it has become hereditary) and intelligence, the one having a bigger percentage of intelligence than the other. Minute creatures like aphides and cheese mites would seem to spoil such a theory, but one never knows. The aphides may have strategies for getting to a greener part of the leaf ahead of competitors which we never see, and cheese mites may bite a friend's tail when they see a succulent area ahead in order to divert its attention. They come in masses and are small and we cannot see what goes on and so we class them as so much dust. We are probably far out. Seeing canaries in cages does not give one a good impression of the intelligence of canaries. They can hop, one would say, from perch to perch and crack seed and eat it. And they can sing for no apparent reason. That they have little reason for singing I admit, but if you keep an aviary of canaries and study them you will see surprising things. You will see no canaries with similar personalities, and if you keep enough of them you will see canaries with most of the faults and virtues of ourselves. Some years ago a man wrote a book entirely on the personalities of canaries. The characters in many novels were colourless by comparison.

But we are not discussing canaries.

CHAPTER 5

THE SUBTERRANEAN HUNTERS

WE ARE NOW going to meet the heavyweights, the Goliaths of the hunting wasps, by name Scoliae. In the main the hunting wasps are small, and most of those that are not small look willowy, rather as if they had outgrown their strength or at any rate sapped it by too tight corseting. The Scoliae have a robust look. They are broad, powerfully built and with strength to correspond. The hornet, popularly supposed to be the giant of wasps, is puny by comparison. She measures an inch in length; *Scolia hortorum* or *Scolia haemorrhoidalis* (both arrayed in the famous yellow and black) are more than an inch and a half, while their span from wing tip to wing tip is four inches. None of the Scoliae are known in Britain, for huntresses, like so many others, are no admirers of the British climate. They live, however, not far away, in France, and we shall have to go again to Fabre who was the first to find out what they hunted, and how, and where.

One grows a little excited. We have seen Tachytes overcome the Mantis, and Cerceris put the armoured beetle to the sword: who will this giantess, as large as some birds, select as a worthy victim? Then comes a depressing thought: perhaps like so many of her colleagues she prefers to feed her baby on a number of small carcasses rather than one big one. Set your mind at rest, she provides only one, which has to last her offspring from birth until it is as large as herself. So it must be big. And it *is* big; but you are going to see no epic fight; your heart will not be in your mouth; you need not shut your eyes—the prey is a grub.

With those great wings one would expect an aerial combat, but Scolia spends most of her life underground, where her wings are of no use whatever, burrowing tunnels like a mole. And it is underground that she meets her prey, the swollen, great-bellied larva of the Rhinoscerus and other monster beetles and there paralyses it.

The Scolia's surgery is probably the most skilful of all the wasps. In her case it is very necessary that this should be so. A mass of tissue without any hard skeleton parts decomposes in no time. Were that mountainous grub to die after the injection it would soon become a bag of putrid jelly, and her baby might as well eat strychnine. On the other hand its fatty tissues enclose muscles of surprising power, and these *must* be put out of action. So this expert operator, though buried in earth, uses her lancet with such nicety that the grub stretches itself out and never moves again except for a faint play of its mouth parts. Not even a tremor or contraction takes place when a needle is inserted at any place.

It is after July that Scolia takes to the earth and lives there, burrowing in mouldy soil nosing out large beetle grubs, paralysing them, laying her egg and then going off, still tunnelling, for another. The worms must stare—or would if they had eyes—to see this unusual inhabitant of their subsoil.

The weak, undersized males never burrow. They fly about upstairs and sip the flowers or hover over the ground and hope that a female may appear from some subterranean expedition. Should one do so the males immediately pester her with their attentions. If necessary for the proper continuance of her work she will allow one of them to have his will with her, but that will not save her from the continued importunities of the rest so that probably she is quite glad to get back underground again. The males of many of the other above-ground hunting wasps behave in the same way, but should these puny Lotharios importune a female when she is busy—when, for instance, she is dragging a carcass home—she sends them about their business and thereafter they leave her alone and wait for some other female who may be in a more willing mood.

Cetonia is a species of beetle and its larva is preyed on by *Scolia bifasciata.* It is a huge larva and has the peculiar habit of travelling on its back. It is the comedian, the Charlie Chaplin, of the grub world. It has a complete set of serviceable legs but instead of using them travels upside down by heaving and jerking its back, the legs meanwhile waving protestingly. Possibly at one time it did this to amuse the others and drunk with their applause practised it so assiduously that the trick became a habit and the other grubs ceased to take notice. When danger threatens, the grub folds itself up in two halves after the fashion of a hedgehog, and the halves are so locked together that it is very difficult to break them apart. A strong fingered man might do it, but at the risk of the entrails of the grub spurting over him.

It is when the grub is in this condition that the Scolia has to operate. Caterpillars, as we have seen, have their nervous ganglia divided out, each segment containing its own and situated in the under part. And this is the case with most larvae. But the larvae of the beetles preyed on by the Scoliae are like the adult form in that the controlling nervous ganglia are in one spot, and that spot is the underside of the neck near the head, which is the only underside spot the wasp can get at when the grub is in its doubled-up position.

While this is lucky for the wasp it is exceedingly unfortunate for the grub, who has taken every precaution and who, but for an anatomical peculiarity over which it has no control, would be wasp-proof. Indeed it calls for a little thought and one asks onself, was the grub made like that for the wasp, or did the wasp find it out and concentrate on that particular grub because it was made like that? It is the sort of question almost bound to bring Fabre swirling to the surface like a trout after a fly. And sure enough we find a long, a very long chapter in one of his books devoted to this very question. He attacks at once, but exactly what he is attacking it is difficult to make out. I believe it is the "Natural Selection" theory, but he soon leaves wasps and goes to men and apes and the Darwinian theory and brings all his big guns to bear and becomes quite wrought up.

I confess I do not understand the heat of scientists about these matters. One only seeks the most plausible solutions to interesting problems. One delves into theories and is grateful for any suggestion that may shed light. One takes cards as it were from the pack and can keep or discard them as one wishes. I gather that Fabre holds the opinion that all life was created in the beginning on a fixed plan which never changes; that the Lord made the Scoliae and made the particular grubs they were to kill, and since the latter would insist on folding themselves up put their nerve centres in the only place accessible to the wasp. I feel myself there is more in Fabre's bad temper on this subject than meets the eye. A child making a house of bricks will often try to use an odd one from some other set which does not fit and the more one tries to make him discard it the more determined the child becomes to use it and the more furious at the consequent lack of stability of his house. I believe Fabre has an idea that *his* brick is not *quite* the right shape, which makes him defend it the more hotly.

In the case of those wasps who provide one carcass which has to last their infant for the whole of its larval life a difficulty presents itself. If the meat must be fresh, what happens when the larva eats into the prey and thus kills it? When a number of small bodies are supplied it does not matter; the grub kills the one it enters but the body is soon consumed and there is a fresh one waiting. With a hard, leathery thing like a grasshopper it is not quite so serious, but the soft, skeleton-less sack of the Cetonia would decompose almost immediately after death. So—with the Scolia at any rate—the grub too must play its part. It is no use the mother carefully paralysing the beetle grub if her child is going to kill it at the first bite.

And the grub *does* play its part. Everything depends on the mother putting the egg on the right spot, the rest must be done by the grub. It must eat carefully, its table manners must be correct. So it devours the fatty tissues and other parts but carefully avoids going in the direction of the vital organs. Only towards the end when the wasp grub is nearing the termination of its career as a grub is the last spark of the prey's life extinguished. It is the height of protracted cruelty, but in studying these huntresses one must shut one's eyes to the sufferings of their victims, for certainly one can do nothing about it. Even Mrs. Peckham, endowed as her writings show, with sympathy and warm affection, watched the fiendish tortures these captives underwent—often through her own machinations—with callous curiosity, mixed at rare intervals with perfunctory commiseration.

This clever eating by the grub is purely automatic. It does not inspect the organs as it comes to them and recognise, say, the liver, and avoid it. It just eats in certain directions, and probably also has a natural preference for such comparatively unimportant parts as the fat and the muscles. Fabre experimented by putting the newly emerged Scolia grub in a different place and it went completely adrift, for in a short time it had eaten something that the beetle grub needed and the beetle grub died and turned brown. The wasp grub forthwith did the reverse; it turned brown and died. Needless to say Fabre did not rely on a single experiment. He made dozens, and they all showed firstly, that when the grub started off at the wrong place it killed the captive, and, secondly, that the captive's premature death meant the death of its guest also, and that quickly.

With a great deal of luck and a great deal of persistence and ingenuity one may witness most of these wasp mothers committing their murders. But obviously with Scolia, operating only underground, that is impossible. Or so it would seem. Fabre's old bell jar had brought him little else than disappointment, mixed of course with a few triumphs. In every case, however, he brought it out with eager hope and great expectation, and his buoyant temperament was correspondingly depressed when nothing happened. But even he, when he put Scolia into his jar, had no hope. Not only would she be distracted by captivity and think only of escape like so many of the others, but the chief element, the subterranean soil, was lacking. But he thought he ought to try, just to satisfy his conscience, so, probably with a shrug of his shoulders, into the bell jar went a Two Banded Scolia and a Cetonia larva.

Never was observer more agreeably surprised. No circus could compete with the rodeo display that followed. (We need a B.B.C. commentator here: I cannot do it properly.) The larva went off—on its back, of course—like greased lightning and the wasp went after it. Round and round the glass enclosed circus ring they travelled, the wasp overtaking. The wasp caught up, jumped on to the Cetonia, and rode it bareback—or rather bare belly. Her mount bucked as it galloped but she made her way over the wide expanse of stomach, through the waving legs towards the neck. The grub then doubled itself up, but it did not remain doubled up as no doubt it would have done had it been enclosed in its natural element. It coiled and uncoiled and hurled itself about. Time and again the Scolia mounted her refractory steed only to be thrown off, and again and again with contortions of her abdomen she tried to get her knife into position. At last she did so and struck it into the plunging form in the neck and the larva was suddenly quiet. She did not remove her weapon for some time. She kept it inserted in the wound and moved it about, searching no doubt inside the body for the actual headquarters of the nerves while her lancet was still discharging.

Occasionally the bell jar had produced immediate results owing to the fact that the huntress of some other species had not realised a jar was there. But after this first attack these others had sought only escape. Scolia, however, in Fabre's circus ring, obligingly rode three more Cetonia grubs and killed them all. She laid no egg on them, so obviously was under no delusions. She just could not resist attacking these creatures; their panic-stricken efforts to escape aroused the tigress in her.

We have seen, with a shudder on my part, how long paralysed grasshoppers can live, but the record is surely held by these victims of the Scoliae. Two, kept in a bed of mould, remained alive but completely motionless for nine months. At the end of that period a kind of resurrection came to them; they moved, turned over, and then began to bury themselves in the mould. When teased they coiled up slowly and moved their legs and mouths. Such deceptive energy often comes at the end; in a few days both were dead, having lived about half a year longer than their murderess.

CHAPTER 6

THE FLY HUNTERS

I

THERE CAN be nothing but warm approval for the killers of flies. Caterpillars may worry gardeners and weevils corn merchants as well, but flies worry everyone. Were we allowed to delete one insect from this planet, the matter to be decided by vote, there is little doubt that the fly would be selected. "Fly" of course is a vague term. There are thousands of insects that might be called such, but to most of us flies mean house-flies and also the smaller creatures of similar appearance that hover about in rooms and never seem to alight except on the ceiling. Bluebottles and green-bottles are also "flies" to the majority.

In its own sphere, the house-fly is a useful creature. It is a sewage farm in itself. It makes excreta sweet and clean, or at any rate unobjectionable. It does not devour our food (to any extent that counts) nor spoil our crops. The trouble is that it does not keep to its own sphere, which is the latrine; the trouble, in fact, is that it likes clean food. So, covered in the filth in which it has laid its eggs, it dines with us at table and carpets our food with bacteria, or swims in our tuberculin-tested milk, introducing into it most of the germs of the cess-pit. It then returns to the midden, and again comes back to the larder or the dining-table—and so on backwards and forwards. Not only does it carry germs on its feet and body but it has the pleasant habit of vomiting before it commences a meal. So with the house-fly's vomit and excreta on not a little of the food we eat in summer—especially on shop-made cakes or food at restaurants—it is not surprising that legions of diseases spread in a mysterious way.

The blue-bottle has no wish to share our food; she does not like it. Like the hunting wasp herself she seeks meat for her babies; a pity, then, she does not kill her own meat as the wasps do, and lay one egg on it like them instead of five hundred. But she, too, is useful. On Nature's pay-roll she comes third in the list of qualified undertakers, the higher places being taken by the green and grey flies and the spade work being done, where necessary, by the cruder Marabout Storks, Vultures, and Hyaenas. When she searches out our Sunday joints she is merely being over-conscientious. To her, it is dead animal matter left lying about and needing attention. From our point of view it is unfortunate. Without this officious busybody our meat might keep for a long time. It might dry, like biltong, and never give offence even if it were too tough to eat. Someone (Fabre, I think) experimented with the dead bodies of small birds. Those kept in paper bags where the blue-bottles could not get at them gradually dried and became mummified. They were kept for three years and during this time never gave off any smell. The others, left uncovered or with a small hole in the paper through which a blue-bottle could pass, dissolved in smell and corruption. Nature, of course, that miser, does not want mummified corpses left lying about: she makes loans at heavy interest but wants her capital back. In larger corpses, not so quickly dried, micro-organisms get to work unassisted by flies. But their work above-ground—which is the normal place—is not fast enough for Nature, who really dislikes offensive matter, so she sends her blue-bottles, and others, to finish the job quickly. Putrifaction is a very involved and complicated chemical process, far more elaborate than anything the Imperial Chemical Industries have ever undertaken. Virulent poisons however are a by-product of this process so Nature puts up a big notice: POISON! NOT TO BE TAKEN. She transmits this notice to the most trustworthy member she has given to mammals, the nose; those cruder members, the ear and the eye, are not sufficiently acute or reliable. So when this dreadful stench comes to us we are warned to keep clear until Nature's Industries Ltd. has completed the job and rendered us down something to grow food on. And she employs a vast number of workers, all of them working a twenty-four hour shift and a seven-day week.

There is another advantage of putting up a nasal notice. It discriminates. To you or me it says "Stand Clear—Danger." To the hyaena and countless other vermin whose help Nature requires the notice is equally urgent but it reads: "Come at once!"

So, according to instructions, one lot pour in and the other lot, holding their noses, pour out, but in the end the experts, the blue-bottles and their kin, quietly finish the job so that you and I and cattle and sheep and green things may live.

All this, although I suppose it should, does not improve our tempers when we find the blue-bottles have been at the meat. And if we take the short-sighted view—as I for one do—our annoyance is justifiable. For blue-bottle grubs can only "eat" liquid stuff and they make their own liquid in the meat as they go along. In short, the blue-bottle grubs *make* meat bad. They exude a liquid of extreme putrifying potency which so far as I know has never been analysed and which surely (or am I wrong?) might contain an agent that has *some* use. One thing I did not know—though I do not suggest it is a discovery—is that blue-bottle *eggs* also emit this putrifying agent before the grubs emerge. I found this out with a humble pair of kippers which I bought one morning and placed in the larder. I did not think blue-bottles would bother about kippers. But evidently they were desperate, for when I took out the kippers to grill them for breakfast the next morning I found a patch of eggs on one and two patches of eggs on the other. So I washed them under the cold water tap, and where the patches of eggs had been the flesh all fell away leaving a gaping hole. It may be the mother blue-bottle herself lays down the putrifying agent along with the eggs. Whatever the cause, putrifaction, in the area of the clutch, has already been started before the grubs emerge.

The trouble with both the fly and the blue-bottle is the impudence with which they enter our houses and treat them as if they were their own. The green-bottle is more diffident and although she deals in meat and corpses in the same fashion as her blue colleague she respects our privacy to a certain extent.

The house fly is in the first eleven as a dodger. It seems to know instinctively the one and only angle to take to evade the furious palm. It also seems rather to enjoy these little tests of skill. But that noble instrument, the swatter, generally gets it. Not always: the apprenticeship must have been a hazardous one, but there *are* flies that are swatter-trained. A point to bear in mind is that that wire gauze affair is a stunner only—it does not kill—and what does it profit a man if he swats a fly and has it buzzing round his face five minutes later? I found this out during a railway journey in Manchuria. I sat with a swatter in one hand and a book in the other and I tried to read and at the same time swipe at flies settling on my person. The flies had assembled in force and finally I reached a stage when my nerve ganglia snapped. I put my book down, sat up, and declared total war.

The carriage was a Pullman with an avenue down the middle and I was the sole occupant of the loose box made up of my seat and the one opposite. Flies were settling everywhere but I waited for those that settled on the back of the seat in front of me: then I let them have it. They fell lifeless, and in a little while a pile of corpses had accumulated on the seat below. Very pleasant it was to see them lying stiff and rigid and looking almost pathetic with their little legs pointing upwards.

I had started in a state of nervous tension bordering on mania, but my new job interested and soothed me. It was more absorbing than the book, which was on the dull side, and the journey was a long one with hours and hours still to go. I had decided to reach the thousand mark but after fifty I stopped counting. The flies were still falling, and thickly, but it seemed to me they were becoming quicker in the uptake. They took off earlier, so that when the wire gauze struck the seat with its usual violent impact, many had already left. This worried me. And soon another thing worried me. I had been working now for nearly two hours and at the beginning, as I have said, the pile of corpses on the seat had reached very gratifying proportions. And it was still good to look at, but latterly, or so I thought, it had not grown to the extent that might have been expected. A dreadful suspicion entered my mind. There were some flies walking about among the bodies, searching for relatives perhaps, that took off from time to time, but these were fresh flies: hale, hearty, unswatted flies. Or weren't they?

There was only one way to find out. I ceased to swat and concentrated my gaze on three little bodies that lay close together on their backs, still in death. I did not allow my gaze to waver for one moment but out of the corner of my eye I saw a Japanese passenger in the loose box over the way staring at me with the same fixity with which I was staring at the flies. Had I been one of his own race he would have pulled the communication cord, but Englishmen are classed as mad the world over.

Then I saw one of those corpses twiddle its feet, struggle, turn over, walk an inch, put its head between its front legs as if it ached and fly off. And not far off another was doing the same thing. What it amounted to was that two hours work had gone for nothing except to train several hundred flies how to dodge swatters. It meant that in future, after swatting a fly, I must also squash it. It involved extra work and the first fine frenzy of my attack had passed, but I did it. Then a Jap waiter came along to say that lunch was served.

I shall continue this account a little longer, though the rest of it has nothing to do with flies; it deals with a dreadful thing that happened to an expensive silk robe.

As I went to the dining car a Chinese followed me and occupied a seat at the table over the way. Like myself he had the table to himself. Evidently he was a wealthy merchant, and was dressed in a heavy robe of mauve watered silk. Evidently, too, he had never had foreign food before. The Chinese, of course, use only chopsticks and look on our array of knives and forks and spoons as so much barbarianism, and the same goes for our food. His table was laid for lunch with a clean white table cloth. The waiter presented him with the menu. It was in English and therefore Greek to the Chinese, but he pointed bravely and vaguely at an item, determined not to let China down in front of Japan. The waiter went away and came back with a bowl of oatmeal porridge, also sugar and milk. The Chinese looked at it and then his eyes roamed the table, coming to rest on the cruet. He took the cruet and put all the contents on to his porridge, all the salt, all the mustard, all the pepper. He must have wondered why they made the ration of pepper so difficult to get out through the small holes. He looked round again to see if there was anything else and saw a bottle of Worcestershire sauce, half full. For some reason he ignored the sugar and milk, perhaps he thought foreigners used them only with tea. He poured all the Worcestershire sauce over his porridge so that the extreme edges of the bowl were lapping with it. Underneath, somewhere, was the porridge; above it masses of salt, pepper, mustard and half a bottle full of Worcestershire sauce.

He took up and studied in turn the implements near his bowl and finally decided on the knife and fork. Then he got busy. Worcestershire sauce splashed over the table-cloth, over his face, over his silk robe. It dripped from his chin. A glazed look came over his eyes—as it did, I expect, over mine as I watched. But splashing manfully into the morass with knife and fork he got some thirty-five per cent of this powerful emetic into his system and splattered most of the rest over his person, the table, and the seat.

He went out shortly afterwards. The Japanese waiter came and cleared up. Not a muscle of his face moved. His almond eyes showed no expression. He removed everything on the table, took the table-cloth away, put on a new one, and wiped down the seat.

To return to flies. After all, one expects them to be thick in China. It is a model nursery for them; the human population is large, and hygiene—to all but a negligible few—unknown. Human refuse is carted continually along the streets or floats down the rivers in open barges. The barges pass silently, but the smell is like something from a gun. One expects to get flies there, and one is not disappointed, but why flies should be even thicker in certain hot dry deserts and in sparsely populated areas in Africa I do not know. I have been to two or three such places, but the worst place—for flies if nothing else—was an out-station called West Nicholson.

We were ten white men and a few natives and a few cattle: not, one would think, a population to provide much breeding material for flies. Moreover the place was excessively hot and dry, and offensive matter dried up in a few minutes in the dry season—and it was in the dry season that the flies came. There were other places as bad for mere fly numbers, but these West Nicholson flies had developed a technique of their own, or rather elaborated a technique which in a crude form is always present. For nearly all house-flies are difficult to dismiss. Even in England we know—especially if we are trying to rest—how a fly will alight on exposed parts with its spread out, sticky, irritating legs, and, chased away, return. The technique of these West Nicholson flies consisted of returning always to the same place. Perhaps it was the headquarters of some amateur dodging club; anyway, it was a point of honour with them, having selected their base, to return to no other spot. This would seem to give *you* a chance. If you missed you had only to wait knowing full well that it would return to the same place and give you another chance. But at the same time others would be operating from the lobe of an ear, the forehead, a bare knee—anywhere uncovered; all strictly obeying the rules of their club. This may seem like exaggeration, and probably is, but in my saner moments I put in a lot of time studying the flight of individual tormentors and they never changed their alighting place. Some returned more frequently than others and I presumed they were the scratch or plus four members.

It was the refinement of torture. The heat was bad enough in itself but with about fifteen flies playing this game on one's scantily clad form, life became difficult and insanity loomed near. I can be facetious about it now, but in that camp at West Nicholson I have seen a man burst into tears under this fly torture and I have seen others lose control and rush about blaspheming.

"Flies" belong to the order Diptera, meaning "Two Wings,"—as opposed to the four wings of bees and wasps and others—an order which includes such dissimilar types as mosquitoes and Daddy-Long-Legs. Commonly classed as the chief fly-hunters are the Bembeces. They are large, rather clumsy-looking wasps with big heads and eyes. Like many other "solitaries" they live in colonies, each with its separate house but the houses only a few inches from each other. Why they live like this it is hard to say. They rarely agree, and fights are common. A matron standing at her front door will exchange a few remarks with a matron standing at hers and in hardly any time at all the two will be rolling and fighting on the ground.

These Bembeces live in sand, often light dry sand of the running type used for timing eggs. Our scientists went astray when they called the caterpillar hunters "Ammophilae." The real sand lovers are the Bembeces. Sand of this type would seem an impossible place in which to build a home, but somehow a long tunnel is made with a room the size of a tangerine orange at the end. That they *do* experience difficulty is obvious, for they will start five or six homes and discard them one after the other until they come upon some place that suits them. Such a place is probably where the sand is moist and firm under the surface. The entrance is always carefully closed by the owner both when entering and leaving. Indeed, where the sand is light and there is no vegetation the door is self-shutting.

This filling in of the sand must make Bembex's goings and comings laborious, and it is strange she should have chosen such a medium, for she uses her passageway more than any of the hunting wasps we have yet met; the reason being she is a new type, ignorant of surgery and anatomy and laying in no stores. She brings her baby its rations when it requires them, as the birds feed their nestlings.

On this account the Bembeces are supposed to be further advanced than the other hunting wasps. Perhaps they are, but I cannot quite see why. The paralysing of game so that it will keep fresh is one of the cleverest things I have heard of. And its advantages over the other method is obvious. The hunting wasp is only given a very short period in which to produce young to continue the race, and it is allowed only one baby at a time—it never even has twins. The paralysing system enables a mother to feed a child in advance and go off and have more children without delay, so that each child only takes up a day or so of her time. Bembex has to wait a fortnight, feeding her larva continually, with the result that six children are the utmost she can produce in a lifetime, and probably few produce so many. This does not provide much margin, especially if you allow for casualties—and the Bembex babies are subject to great hazards, as you will appreciate later. We sometimes marvel at the fecundity of insects. A queen bee can produce about half a million young. Other insects produce still more, yet I doubt if any creature on earth, including birds and mammals, is limited to so small a family as the Bembex Hunting Wasp. Nature is inconsistent: idiotically profligate at times and niggardly to a degree at others. Woman-like, she has her favourites and these favourites not always the virtuous ones. But I suppose we must defer to the scientists and agree to put Bembex in an advanced position, about halfway between her colleagues and the communistic societies of the social wasps.

Like the social wasp Bembex kills her prey brutally and with a complete lack of technique. Of course there is no need to paralyse it even if she could, because it is required for immediate consumption only. But the crudeness of her butchery is probably due chiefly to the agile nature of the subject. The game that is paralysed, the caterpillars, beetles, grasshoppers, and the like, are creatures that can be faced up to, out-manœuvred, half-Nelsoned, held down, and operated on in comparative comfort. The tricky, dodging fly does not lend itself to this treatment. Moreover it flies. None of the animals that receive expert nerve treatment are accustomed to use their wings those that have them. The only other flyer patronised by the hunting wasps is the bee, and she too is killed.

When Bembex goes off hunting she seeks just a fly. Unlike so many of her family she does not confine herself to one species. Indeed her ideas about what constitutes a fly appear to be almost as vague as our own. Blue-bottles, green-bottles, house-flies, gadflies, any old fly. She discriminates in one particular only—size. The flies first given to the larva are small, and it is a very small one that receives the egg. When the egg is laid Bembex shuts the place up and goes away. She has about three days leave of absence. Most of this break is spent cleaning her front doorstep and arguing with the neighbours. She also visits flowers and gets nutriment for herself. But she knows intuitively when the egg will have hatched and the larva eaten its first fly and she will manage to be there with another at the correct moment. She has still time to spare. The fly is small, but so is the grub and it cannot eat a whole fly in less than a couple of days. So there is more cleaning of the front-door step and more arguments with the matron next door. These arguments, though they involve frequent fights, do not interfere with the working of her subconscious mind which tells her when her larva has finished its second fly. And as the grub grows, so does the size of the flies brought to it. But the size of the flies in no way keeps pace with the capacity of the grub. The mother soon has no spare time at all and towards the end she has to make almost hourly visits.

I have spoken of Bembex's habit of cleaning her door step. Ladies, particularly Yorkshire ones, do this also when they, like the Bembeces, live in a thickly populated area. But the motives in the two cases are opposed. Ladies do it to make their doorsteps conspicuous—whiter and cleaner than those of their neighbours: Bembex's object is to make her doorstep *in*conspicuous, to level off the fallen sand so that the keenest eye cannot detect any break in the surface, anything to show that there is a tunnel underneath leading to a chamber containing a grub. There is another reason also; this levelling-off process is combined with a careful picking out of larger matter, bits of stalk, leaves, grains of sand, anything that might obstruct her passage. She will be off soon to catch a fly and when she comes back she will have to get through that shifting sand into the tunnel, and she has every reason for wishing to do so quickly—the life of her baby depends on it. She is oiling, so to speak, the hinges of the self-shutting door.

And if you look round you will see why. Squatting motionless not far off, apparently sunning themselves, are three or four—perhaps five or six—red-eyed flies. It is the last place you would expect them. Gazelles steer clear of the lion's lair; poultry do not visit the fox's burrow. But if flies pester us they pester these professional fly-killers infinitely more. They are the curse of their lives. Worse than that, they threaten them with extermination. A paradox this, without flies the Bembex race would die and because of flies it is unlikely to survive.

All those waiting flies are expectant mothers, but they have taken no steps in the matter. They have not booked their nursing home—yet; they hope to do so shortly. The bearing of young is easy or not according to the species and the life led. To European women it is, as a rule, a matter of some difficulty; yet native women working in the fields can retire to a hedge, have their baby, cut the cord with a piece of broken glass and be back working within the hour. The hen laying her egg, although she proclaims the fact to all and sundry afterwards, makes very little fuss about the actual laying; yet even she has to go to her nest when her hour comes and sit there some time before she is delivered. She does not wonder whether she will lay her egg now or wait till some other time when she has more leisure. She *has* to go. Insects experience less difficulty. The queen bee walks along with her retinue and deposits her eggs sedately in the cells wherever necessary. The hunting wasp can usually hold her egg until the carcass is ready for it. Not always: observers *have* noted an egg drop prematurely from her before she got the carcass home.

But for restraint and timing nothing can touch these waiting flies. They have fertilised eggs ready whose laying they withold at will over long periods. They may have to wait a week or they may have to do it suddenly almost in the time it takes a tennis ball to bounce off a wall. What they desire is for Bembex to take over their babies and feed them. That this will force the babies to be cannibals does not worry them, nor will it worry the babies. Their only way to accomplish this is to lay an egg, or eggs, on the body of the newly slain fly as it is taken in. Bembex knows this; hence those preparations for a quick entry.

So the red-eyed flies squat there—like the "weird sisters" of Macbeth—and in course of time, flying high, comes Bembex to her camouflaged nest. She carries a fly between her legs and she spots these waiting thugs. She checks and hovers, and in her distress she whimpers. It always seems strange to me that bees and wasps should express their emotions through the same sound waves as ourselves. Their throats and mouths are voiceless, they talk with their wings or through holes in their sides and stomachs, and yet, when it comes to fundamentals, they speak our language. One need not go to a special school to be able to interpret the shrill yelp of the bee in pain, its spitting curse when about to sting, or go to insect music classes to appreciate the contentment in the song of the bee that is gathering nectar. And the whimper of Bembex as she hovers above those waiting sisters expresses just as plainly a pitiable indecision. She longs to bring her baby its food, but she fears to do so.

The pregnant ones sit motionless, though surely this is the wolf who is descending and they are the lambs and the wolf bears the newly slaughtered body of one of their members to prove it. Yet it is all too plain that it is the wolf who is afraid—not they.

When Bembex in her slow whimpering descent draws close to ground, the sisters take to the air and close in on her, their red eyes on the corpse she carries. They know all about Bembeces and they are ready for the moment when she must push her way through the sand-filled opening to her burrow. She will push through very quickly when she does, but just for one moment she will be unable to turn round and the body of her prey, still between her legs, will drag unprotected behind her. Usually, before she descends to earth and tries to dodge into her tunnel and slam the door, she spends some time chasing these harpies. It is waste of time. It is like a bull chasing terriers—when the bull turns they are at its heels again. But terriers are noisy and the sisters are quiet. Whilst she is flying in the vicinity of her nest they are never more than an inch away from her hindquarters and the corpse that dangles there. Sometimes Bembex tries a trick. (Did instinct teach it her or did she think it out herself?) She flies away into the distance and out of sight hoping the sisters will fly after her. Her idea is to draw them away, lose them, and dash back before they return. Alas, it rarely comes off. The sisters are experienced and do not fall for simple traps like that. They let her go and take up their posts again.

An observer saw a Bembex making this same feint drop its booty by mistake as it sped away. Here it would seem was a heaven-sent chance for the flies—the dead body they desired lying in the open unprotected, presented to them, as it were, on a plate. They could lay every egg they wanted on it. But they did not touch it. And the Bembex too when she came back discarded it after a careful inspection.

This would appear something very like considered thought on the part of the flies. They had been on the heels of that carcass for some time in the hope of laying an egg on it and suddenly they had it. And they refused it. One fly of course is not enough for their larvae. They require a succession brought by the Bembex long after they have gone away. But do they know this? Apparently. And anyway how do they know Bembex will not come back and carry the corpse in? For Bembex obviously had the idea in mind when she inspected it. I should like to know what passed through the mind of both parties, for these things need explaining however much one hesitates to grant thinking power to a fly.

Sooner or later Bembex makes her dash, and the sisters make their dash too. They may succeed or not. If they don't they wait till the wasp comes with her next fly—or the one after that—they are given several chances, so that it would seem that Bembex's chances of escaping them in the long run are remote.

When Bembex comes out after depositing her prey she goes for these flies, but she goes for them in a half-hearted way. It is more a shooing away than a real chase; much as we might try to shoo away a tame goat, and it is treated with equal contempt. Yet she is a professional fly-catcher and if she wished she could kill them. Why does she not? Many observers ask this question, but none can answer it. The parasite fly is somewhat smaller than the one she usually selects, especially later on, but to kill them would surely give her satisfaction and would moreover reduce their numbers and give those that remained a greater respect for her. Is it that the care she has to take to avoid them when bringing in her prey has given her an inferiority complex, an automatic dread of them?

Fabre tells us exactly why the Bembeces do not kill them. He says: "The harmony of the universe, the laws that regulate the preservation of species will not have it so."

Which is as clear as mud to me.

What happens when the matrons succeed and lay their eggs while Bembex is busy getting through the door? Fabre, to whom we owe so much and whom I, for one, reward with sneers when he begins to theorise, has studied the question thoroughly. He has brought up these "happy families" many times.

The fly eggs are taken in on the dead fly and hatch out, and the little grubs begin eating the property of the rightful heir. But provided food is ample both they and the wasp larva muggle along quite pleasantly together and feed out of the same trough like so many little pigs. The mother Bembex pays her regular visits, bringing provender. What does *she* feel about it? There are limits to our knowledge and all the observers in the world cannot observe the mind of an insect. Is she alarmed at seeing so many—up to, it may be, twelve—grubs feeding where there should be only one. Does she realise what has happened but go on providing food because her own grub is amongst them? If she could just take hold of the gate-crashers by the scruffs of their necks and throw them out it would be very simple. But she does not. Perhaps she cannot recognise her own grub from the rest, or perhaps Fabre's Harmony of the Universe stops her. If so, there is going to be very little harmony for the Bembex grub soon.

The dice are heavily loaded against the rightful baby. For one thing its competitors are usually about five or more to one and for another, and more serious, they grow faster. At first all get enough, but soon it is a matter of one little pig trying to feed at a small trough with five or more very much larger pigs. In a case like that the little pig gets pushed away and never gets near the trough when feeding time comes round. In due course the fly grubs pupate. *They* are all right, but the Bembex grub is not. Weak, under-sized and starved, it has not the strength to make itself a cocoon, nor do its sickly glands contain the necessary silk.

Or it may meet an even worse fate. The mother goes to and fro very busily with flies, but instead of one she has several to feed and should she have to be away hunting for a longer time than usual the fly grubs experience the pangs of hunger. Then they fall on the son or daughter of the house and tear this deeply wronged creature to pieces and devour it.

What happens when fly eggs are introduced towards the end of the Bembex grub's larval life? I do not know. Perhaps this never happens. Perhaps those know-alls, the pregnant sisters, don't lay eggs on corpses entering such a nursery. But if they do I should imagine even such small fry could jeopardise the future of the Bembex grub. The making of the cocoon is intricate work. A suspended hammock has to be spun, a hanging silken sack. Then grain by selected grain this hammock must be lined with sand which is cemented on. Then comes a thick, smooth varnish, the whole making a waterproof shell strong enough to withstand the maximum pressure between human fingers. And all the unaided work of the Bembex grub. A spider making her web has hardly a more complicated task. This work, especially in its earlier stages, is delicate and takes a lot of space and a number of wriggling fly grubs in the confined space of that small chamber would, I feel sure, interfere with its making and probably stop *pupation* altogether.

It would be interesting to know how often the flies succeed. Unfortunately it is not an easy matter to dig out a nest in such condition that it can be examined. At the first thrust of the spade everything collapses. The Peckhams managed to examine ten nests and out of these only one was free from parasites: the others contained from two to five "lively" maggots. One certainly wonders how the Bembex race survives.

We have seen Bembex inefficiently chasing parasitic flies, and we have surmised that she is not showing her real form: for how otherwise can one account for those newly slain bodies carried between her legs and arriving continually. She must get them somewhere; and she must put a lot more vim into the business than she does with the parasites. But to see her in the act of getting them is very difficult. She goes off into the blue, and we cannot go after her. Flies are ubiquitous. She may get them in high open spaces, in the shade of a tree, on a wall, anywhere. One cannot arrange to be present when it happens. And there are no tricks here that one can play; no substituting of a fresh fly for her dead one, for she goes straight in with it; and you have all the fresh ones you could want in the shape of the parasitic sisters already stationed there. No, if you wish to see a kill you must ask Dame Fortune to show it you—and you know what she is!

Bembex can only be seen operating by the rarest of chances. And this rare chance, to be of any use, must come only to a naturalist. Many a farmer's boy, many a gamekeeper, many a Mr. Smith and Mr. Brown walking in the country, must have seen a Bembex strike down a fly and thought nothing of it. To them it would not be worth watching, let alone recounting. One insect doing something to another—they would never dream that such a thing could be of interest to anybody. So the event goes unrecorded.

But Fabre saw it. He was not trying to: even he, sanguine and persevering as he was, had finally decided that it was impossible to see a Bembex kill a fly. It happened, as it must, by accident and for once to the right person. An umbrella is a useful thing but its use is limited. It can be used to keep off rain, or, at a pinch, sun, but not normally to show one a Bembex killing a fly. The weather was exceptionally hot and Fabre felt he could not stand any more long hours in the broiling sun. So on his next trip he routed out his umbrella and took it with him, and opened it when he neared the arid expanse he was making for. Flies revel in the sun, but apparently they like shelter from it at times, for quite a number came underneath with him and sat on the underside of the silk cover. He walked on, and then—— But I will let him tell the tale.

"Bang! The light cover resounded like the skin of a drum. Perhaps an oak had dropped an acorn on the umbrella. Presently, one after the other, bang bang, bang! Can some practical joker have come to disturb my solitude and fling acorns or little pebbles at my umbrella? I leave my "tent" and inspect the neighbourhood. Nothing! The same sharp sound is repeated. I look up at the ceiling and the mystery is explained. The Bembex of the vicinity had discovered the rich provender that was keeping me company and were impudently penetrating my shelter to seize the flies on the ceiling. Things were going to perfection: I had only to sit still and look.

"Every moment a Bembex would enter, swift as lightning and dart up to the silken ceiling, which resounded with a sharp thud. Some rumpus was going on aloft, where the eye could no longer distinguish between attacker and attacked, so lively was the fray. The struggle did not last for an appreciable time: the wasp would retire forthwith with a victim between her legs . . ."

Well, no one could possibly have been in a better position to see how the kill was made but evidently even Fabre could not follow the details. His account boils down to his expressive "Bang!" and a fly being carried off by a Bembex. That is much how a hawk works. I had a canary once that escaped from its aviary and was sitting on the top and I was looking at it and wondering what to do. And then, without warning, *bang!* also. A heavy bird had struck the top of the aviary and gone, and so had the canary. Nothing could have been quicker, and although I was close by and watching I gained no data at all as to how a sparrow-hawk takes its prey. Fabre says he has seen Bembex when carrying off flies that struggled crush their thorax and head. After watching our expert assassins we shudder at such clumsiness!

The Peckhams spent a lot of time studying a colony of *Bembex spinolae*. Although this colony was even more quarrelsome than most, it had the social instinct deeply rooted. The inhabitants liked to do things together. For instance, if a hunting expedition was arranged practically every one would join it. At one moment the town would have its full complement of busy matrons, cleaning their doorsteps or watching their neighbours clean theirs, shooing flies away, gossiping, quarrelling. Then one or two would rise and make off. Probably these few had arranged to go off together, but if they hoped their going would pass unnoticed they greatly deceived themselves; the eye of the Bembex matron misses nothing connected with her neighbours. So every other matron would decide to go after them. Perhaps they disliked the idea of others getting somewhere first and taking all the best flies. Anyway, the remainder would make haste to shut their front-doors and dash off after the others and the town would be left deserted except for the ever-present multitudes of flies—the creatures the inhabitants had gone off to hunt!

And in about fifteen minutes the whole company would come straggling back, a disorderly mob, bringing home their coals to Newcastle. They would come in twos and threes, but more or less together, and as might be expected only about half of them carried flies. If they *had* to come back all together obviously only those on the scene first would have had time to make a bag. In every case, those that had *not* caught flies tried to remedy the matter by snatching the booty from those that had. The successful huntresses lost no time in dashing inside and slamming the door, attacked to the last by the unsuccessful ones who, for the time being, joined forces with the parasites. Any Bembex returning with an especially big fly became an immediate mark and was pursued by large numbers of friends, just as a chicken carrying a worm is pursued by its brothers and sisters. Some got safely inside, but the return from the hunt always terminated in a free-for-all fight : that famous fight, so well known to us, between the "haves" and the "have-nots" which usually ends in all being "have-nots."

I have said that Bembex bears only five or six children in her life. This is computed from the fact that the nesting period of the Bembex is not more than three months and the time required for the larva to develop is two weeks. The suggestion has been made that Bembex may possibly have other homes; that she may supply food to two, or possibly three, babies in different nurseries at the same time. An experiment of the Peckhams, though not quite conclusive, goes to show that she rears one child only before starting her next. They marked six wasps with different colours and near their nests they put pebbles painted a similar colour to the owner. All six, watched for three hours one day and one and a half hours the next, came at regular intervals to their nests. This regularity was so unvarying that it was practically impossible that they could have been feeding another baby at the same time. Moreover they were seen to visit no other nests.

II

Crabro comes next on the list of fly killers, though if industry and sobriety count she ought to come first. Most decidedly she is the hardest worker of all the hunting wasps. The species of Crabro are innumerable, and though most confine their butchery to ordinary flies, which they destroy wholesale, one or two gather aphides, and others moths in their season—neither of which we grudge them. So far, rightly or wrongly, I have avoided too much classification, too much stressing of species, and as far as possible referred to a wasp by its generic name. But it is impossible to lump the Crabros together; the species are too dissimilar. Some are big, others hardly larger than midges, and while most are square-headed and thick-waisted, as their temperament would lead one to expect, a few possess the long thin waists so fashionable in the hunting wasp world. They are no more constant in the colours they wear; yellow and black insects, black and scarlet insects, and insects purely black may all be Crabros. As for their habits, some make their nests in the ground in the normal way but others bore into wood. Even here they differ, for one species must have rotten wood and another sound wood such as poles and gateposts. Some again bore into the stems of briars, brambles, reeds, and similar plants.

With creatures so different in so many ways the question may be asked how is any one to tell that they are the same genus? How, for instance, is the ordinary man to know that a large yellow and black wasp making a nest in the earth and storing blue-bottles is of the same genus as a tiny black one boring a hole in a bramble and introducing midges? And why were they classed together in the first place? The answer is that each genus has its own distinctive fingerprints, and these have been classified with as much care as if they belonged to so many criminals. "Fingerprint" is a figure of speech, but the principle is the same. The fingerprints of the hymenoptera lie in their wings. Using—unless you have very good sight—a lens, you will notice four faint veins, called "nervures," stretching from the body end towards the wing's extremity. The top one ("coastal nervure") runs along the top edge of the wing, and so will not be noticed. These nervures do not carry on as straight lines to the wing's extremity, but about half-way there branch out and form little irregular areas like so many fields plotted on a small scale map. It is the number, position, size and shape of these little areas that form the "fingerprints." We will not bother to describe the pattern of Crabro's wings, but it is by this pattern that you may recognise the genus. There are other details but it is not necessary to go into them here.

The number of the species may be vaguely inferred from the fact that, according to Edward Step, there are 37 in Britain —not by any means a favourite resort of the hunting wasps, those lovers of sun and heat. But Crabro is rather an exceptional wasp. Whereas a single small cloud coming over the sun is the signal for a lot of varieties to knock off work Crabro goes on methodically, and moreover—or some species do—she works at night as well; a thing unheard of in the whole wasp world except amongst the hornets. In fact most of the hunting wasps call it a day long before the sun is anywhere near the horizon. To do them justice I ought to add that these others, during those periods of heat when they do work, go at it with a frenzy that is quite awe-inspiring to watch, while Crabro, who never lays off, works with dull methodical stolidity.

It is not easy to prove that a wasp never *does* lay off work. One cannot keep one's eyes on it a whole day and then the whole night following and then the next day and the next night after that, and so on. The Peckhams, however, hit upon an ingenious arrangement for showing how long a wasp kept on working—and let no one start or turn pale; the device would not be suitable for use with us.

The species they selected was *Crabro stirpicola*, a worker in briar stems. I say "selected," but that, of course, is quite wrong. A naturalist does not "select" a subject for study; the subject selects him. He *can* arrange to watch a *colony*, but with Crabro, and many others, he must take what comes—and be thankful. His normal procedure is to wander off with various impedimenta such as lenses and bottles—and hope. And the greatest of these is Hope. On his wanderings if he is lucky he may see some hunting wasp doing something. He does not get peevish about its species, nor even its genus, he stops and watches it. And if it is lunch-time he goes without his lunch, and if the afternoon is hot he is roasted, and when tea-time comes he goes without his tea, and if he is dealing with a Crabro he goes without supper too.

Well, the Peckhams came upon a *Crabro stirpicola* that had commenced her work of excavation into the stem of a briar and reached a depth only of about the length of her body. There was another one a few feet away doing the same thing. She, judging by the length of tunnelling done, had been busy for about two hours. A watch was put on both of them. Mr. Peckham, I expect, watched one, and his better half the other. Load after load of bitten-out pith came up in the shape of pellets which were held between the hind legs and the stomach. Having obtained the maximum amount of excavated material the wasp, in both cases, would walk backwards up the inside of the stem and push away the pellet when she came to the top. To further its dispersal she would give it a kick with her hind legs and knock it over the edge. Then down again; so that all that was ever seen of her was the tip of her abdomen and a couple of hind legs. The two of them, or rather those portions of them mentioned, appeared and disappeared with the regularity of machines.

The Peckhams stayed watching until seven o'clock that evening, and then fixed up their simple but ingenious arrangement. It was a long bottle inverted over the top of the briar stem with the bottom (the mouth) plugged so as to catch the pith pellets flung out by the excavators. One might have thought that being enclosed in a bottle would disconcert these wasps, but they were so intent on their work that they never even knew it was there. After an hour the Peckhams noted the amount of pith collected at the bottom. This gave them a measure of wasp labour per hour for future reference, though due allowance would have to be made as time went on for the increasing depth of the tunnel which would involve longer load-carrying journeys. They came back with a lantern at 9.30. Both wasps were still busy and the measuring glass showed that they had not ceased work during the period. They emptied the pith away and set their trap again.

Four o'clock in the morning was the time of their next visit. To their very considerable surprise work had been continuous in both cases. Indeed, practice had made more perfect for the measure showed that they had got out more pith than they would have done working at their former speed, in spite of the increasing length of the tunnel. Back to bed went the Peckhams, but they were on the spot again at 8.30. A doctor's life is hard but a naturalist's is harder. The Crabros had *not* been to bed and had not ceased in their labour.

At nine o'clock the one they had first seen, whom I will call "A" came out and flew off—probably to get a well-deserved snack—but came back in seven minutes and immediately resumed work, keeping at it without a pause until two in the afternoon when she went away again, doubtless for another bite—and never came back. Death for these creatures in the shape of a bird, a dragon-fly or what-not is always round the corner.

"B" came out headfirst at 2 minutes past 9 and after looking around decided to go back. Perhaps she thought she had not done enough to justify a snack. After a little while she came up again, and again went back. At twenty-five minutes past nine hunger conquered and she flew away. Her breakfast, whatever it was, was not prolonged and she returned at 9.35 and instantly set to work with her excavating tools and improvised wheelbarrow. She kept at it in her methodical, unceasing way and when her observers left at dusk she was still working.

As a matter of fact, in addition to boring a long tunnel, she was also wearing out the two Peckhams. They had started on this recording job full of keenness, little thinking what it was going to let them in for. Their admiration for the incredible industry of this little creature was tempered with a devout wish that she would lay off.

At 10 o'clock that night the recording glass showed that she had never ceased. They came back at 7 a.m. the next morning and, as they said, could scarcely believe the testimony of their senses, for the recording glass told the tale of unceasing toil through all the long hours of the second night.

At exactly 9 o'clock the head appeared at the top of the stalk and she flew off. The tunnelling was done.

So in making her nest she had worked continuously, or practically continuously, for two days and two nights. The rest is tragedy. For a couple of days more she was just as busy bringing in flies as she had been in excavating; then, like the other, she made a flight and did not return. However, her work was not altogether in vain. She left one child, to prove, we hope, as industrious as her mother and to bring forth others like herself.

Had she lived, this little worker would have given birth to ten or twelve young in that one stem. She had bored down to a depth of 16 inches and completed and stored one cell at the bottom. These cells when completed and stored are sealed off one above the other by divisions of pith, a baby and flies in each. The Peckhams waited for four days hoping for her return; then carefully broke into her home. The larva was there, going strong and having a good time amongst the carcasses of 18 flies. It spun its cocoon two days later, and they kept this cocoon and it came out the following spring.

A list of the various Crabros with precise details of their nesting places, habits, and prey, ought, I suppose, to be given now. There are many reasons why I should not do so, the chief one being that they are not known. As usual the classifiers are ahead of the observers—miles ahead. Moreover, the Crabros themselves make things difficult. Most of the hunting wasps are conservative in their ideas; they adhere rigidly to one type of nest and one species of prey. Yet according to Step at least one Crabro, *clavipes* by name and called by him the Club-footed Digger, a small lady dressed in black and pink, and one whom you may find catching flies on window panes, makes nests not only in the sand but also in the stems of bramble, elder, ash, spirea, hollow reeds, and the straw of thatch. And we know that all of them care little what fly they catch provided it *is* a fly. Not only that, for the Peckhams found a Crabro (*interruptus*) bringing white moths to nests in a log on the seashore.

Incidentally, Mrs. Peckham seemed to have rather a down on Crabros. She called them "unimaginative" and she blamed these particular Crabros for waking up in the morning and going straight off to work. She said they had the splendour of one of the most beautiful bays she had ever seen right in front of them, but never paused to give it a look. I have heard insects blamed for a great many things but never before for taking insufficient interest in the scenery.

Some doubt seems to exist as to what Crabros do to their victims; whether they paralyse them, kill them, or just lock them up alive. I think they are mostly killed, for as I said before the difficulty of paralysing a fly would be extreme. But the Peckhams, in the case of one species, found flies that were far from being paralysed or killed. The wasp in question was *Crabro seximaculatus.* This species bores holes in the spreading roots of large trees; a tough job. As they bring the sawdust out they spread it around with their mouths and feet and then blow it all away by circling above it and fanning with their wings until the last speck has gone. The idea, presumably, is to eliminate anything that might attract the attention of parasites. For those ghoulish creatures prowl around the homes of all the hunting wasps, though paying particular attention to the Bembeces.

There were five Crabros operating on one root and they selected a hole and detained the owner when she returned with a fly. By "detained" I think they mean nothing more drastic than preventing her from entering her hole. The wasp submitted to the detention with patience, but passed the time by transferring the fly she carried from the second pair of legs to the third, a manœuvre of which the fly took advantage to escape and fly "gayly" away. The late owner took her loss philosophically and went off and caught another which she was permitted to store without detention. They opened her tunnel some days later, presumably with a chisel. They found flies and gnats in the cells, all of which seemed to have been brought home uninjured. When the latest cell was opened some of the prisoners flew away, others walked, and all were "lively."

The wasp egg was found on the underside of the neck of one of the flies, though what state of liveliness this fly was in is not recorded.

This of course conflicts with all our notions. How an egg could remain on a lively fly is difficult to understand, and how a delicate grub could deal with a boisterous room-full of live insects is also puzzling. Perhaps incarceration killed the flies before the grub hatched, for evidently the flies in the other chambers they examined were dead. Also, it becomes increasingly evident that liveliness to the Peckhams embraces almost any state except death itself.

III

Oxybelus, the Swift Darter, has a technique of her own common enough with many insects but unknown to the other hunting wasps; she mimics her prey. In other words she looks just like a fly, and acts like one too when the occasion calls for it. *Oxybelus argentatus*, for instance, a species found in Britain mainly amongst the sand dunes in the west, has a downy, silvery coat and preys chiefly upon *Thereva annulata*, a downy silvery fly of similar size. So when a party of Therevas arrange a dance and flit and hover in the meaningless way they (and we) have on these occasions they may be joined by a strange Thereva who bobs up and down with them and evidently knows the steps. This new arrival, while gyrating, curtseying, bobbing and the rest is also marking out the best nourished of her partners, and in the middle of one of the movements this partner is pounced upon and borne off. Or a fly, sitting on a leaf in the sun and giving herself a leisurely clean-up finds herself joined by a companion. Only a casual glance is given, and the toilet is resumed, to be terminated abruptly.

In most books it is stated that Oxybelus stings her fly in the thorax and then carries it home *impaled on her sting* like a sausage on a skewer. This yarn was started by that immaculate observer, Fabre, who so rarely slips up on matters connected with observation. Others, taking him as a Bible, put it down as an accepted fact that did not even require comment. Yet it is strange. The sting of the honey bee is a toothed affair, comparatively thick and blunt. Not only could she manage to carry a fly with it, but once it was well and truly home would have no option in the matter. The social wasp also has a serated sting and could, I suppose, at a pinch use it as a kind of prong. But the sting of the hunting wasps is a smooth, fine needle, a delicate surgical instrument; a lancet made for nerve operations—not haulage. Edward Step does not go quite so far as to say that Oxybelus carries the fly *by* her sting, but he says, as if there were no doubt about the matter at all: "She (Oxybelus) catches her prey by descending upon it either in the air or when it is resting, stinging it in the lower side of the thorax, and whilst the sting is still in position carries it to her burrow, entering head foremost." She may, and does, enter head foremost, but I doubt very much whether she keeps her sting in position.

Consider a moment; whilst the sting is inserted it injects poison and this poison comes from a sack which when empty has to be refilled by a fresh brew taken from the body. Why should a wasp let this precious stuff drain out of her into the corpse of a fly who does not require it? Verhoeff says that *none* of the Oxybeli sting their prey but crush the thorax with the mandibles just underneath the wings—the centre of the nervous ganglia. It all shows how difficult it is to get at the truth. Like medical experts in a murder case, these proved observers make conflicting statements.

But I think the Peckhams have solved the matter. They noted that Oxybelus brings her prey home face upward and clasped by the head between the *third pair of legs.* Oxybelus is unique in carrying her prey like this and it gives her a very unusual and comical appearance, for practically the whole body of the fly sticks out behind her, almost as if it were following her, or *as if impaled on her sting.*

That is probably how the mistake (if it is a mistake) originated, especially amongst observers so accustomed to the normal method of grip; viz. between the second or second and first pair of legs. In any case the sting could not be seen in this position, inserted or not. Latter, however, says he has *seen* an Oxybelus lift a fly up in the air impaled on her sting. So there you have the two schools of thought and must take your choice.

Oxybelus is not a genus of numerous species like Crabro. There are three in Britain and all act in more or less the same way and make their nests in sand. On one point there seems to be no dispute at all; they kill their prey. Even the Peckhams were unable to find the slightest trace of liveliness in any of the nests they examined.

A maddening thing about the hunting wasps is their trick of leading one up the garden path. They will start a nest and when it is almost completed and one is indulging in excited anticipation of the time they will begin to provision it, leave it and go away and start another. And then, as often as not, leave that one too. And so on half a dozen times or more. All, that is, except Crabro and Oxybelus. Crabro, Mrs. Peckham did not like because it was so stolid and paid so little attention to the scenery, but she fell for Oxybelus. This is what she wrote (I feel sure it was she and not her husband): "It is thus, dear little Oxybelus, that we dwell upon the thought of you and your pretty ways. No other wasp rose so early in the morning" (*Is* this quite fair to Crabro?) "no other was so quick and tidy about her work, so apt and business-like without any fuss or flurry. No other was more rapid and vigorous in pursuit of her prey, and we think with admiration and gratitude of the number of flies that you must have destroyed in the course of the summer."

IV

By no stretch of imagination can a frog-hopper be called a fly, yet this seems the most convenient place to give a quick review of those that hunt it. In actual fact the frog-hopper is a species of cicada and so really ought to have been put in the grasshopper section. Any one will tell you that there are no cicadas in England, but there are, and this is one of them. Being immersed in what look like soap-suds it cannot emit that shrill incessant cry that in its larger, foreign relative charms some hearers and drives others mad (like the wireless). Even in its adult form, when it is unlathered and hops about and eats grass, it is mute. So are the other tiny forms of cicadas that we possess—at least to *our* ears. It makes its "cuckoo-spit" by biting into the plant and sucking and exuding the liquid until it finds itself in a pool. It then commences to blow bubbles and make this clear pool into a mass of froth. Not everyone will agree with this. Some scientists say it is excreta, and others other things, but Professor E. S. Morse made careful studies and observations, so I think he is entitled to belief. The spit serves two purposes; it prevents desiccation—Nature's chief headache with us land dwellers ever since we crawled from the sea—and it protects the hopper from enemies.

At least it protects it from most enemies, but a wasp, to whom Step, with a somewhat free translation of the Latin, *Harpactus tumidus*, has given the intriguing name of "Puffed-up Robber," and certain species of the genus Gorytes, dive in and extract indignant nymphs from their soapy citadels. And they feed their young on nothing else but hoppers.

These particular huntresses have to be especially careful to close their doors whenever they go out, for another wasp called Nysson, of similar appearance to Gorytes, also insists on bringing up her babies on frog-hoppers. But she dislikes getting wet and soapy, she prefers Harpactus and Gorytes to do that, so she lets *them* store up the frog-hoppers. She goes into their nests when provisioning is complete and lays her egg on one of the hoppers in the piled up mass. Her child too plays its part, for on emergence it first eats the larva of the owner of the burrow. Therefore, frequently, these nests next spring produce Nyssons instead of Puffed-Up Robbers or Gorytes.

The Nyssons, although wasps, are really no better than the parasitic sisters who laid in wait for Bembex. Indeed they are worse, for those hags did respect closed doors and feared to venture into dark tunnels. Nysson will dig her way through the sand-filled door, pass down the tunnel and deposit her egg on the provisions inside.

Nysson is a sort of sister of those other two and though she pesters them she scrounges on no one else. There is another, a wasp also, a female as beautiful without as she is vile within, and known as the Ruby-Tailed Wasp. This lovely creature will try to wreck the home of any hunting wasp though she shows preference to those of the two frog-hopper huntresses. However, luckily for Gorytes and the Puffed-Up Robber, she is afraid of tunnels.

CHAPTER 7

THE SPIDER HUNTERS

A NUMBER of people are (to use that new and suddenly popular word) allergic to certain insects. A moth terrifies one; a Daddy-Long-Legs another. This dread as a rule is genuine the terror is real. Probably it originates from a fright given in early childhood. Bowers of the Antarctic was terrified of spiders. The fear in these instances must not be confused with dislike. A small percentage of men and women have an unreasoning fear of spiders, but almost every woman dislikes them, and regards them as her special enemies. This is not because the spider with its webs causes women extra work (though they by no means love it on that account) but because it advertises their neglect. The charwoman has two informers at work against her—dust and spiders.

The average housewife seeing dust reacts as if dust were some unknown phenomenon. She recoils, then vigorously puts it into circulation again with a duster. And when once more it settles, as it must, she expresses the same incredulous surprise. It is as if a man were amazed every morning to find that he had to shave. Spiders are in a different category. The last thing they want to do is to advertise themselves or to give any information to anybody about anything. They have been at great pains to be inconspicuous and their webs, by themselves, are practically invisible. When you sweep dust away the dust does not mind, the spider does. An amazing amount of care and trouble went into the making of that web. Dust is a double betrayer; it reveals the spider's web as well as the absence of a duster.

I once spoke with a charlady, a town dweller, who had made the discovery that spiders *do* make webs out of doors. She had seen a big one in a tree. It showed, she told me, that those pests *could* do it outside if they wanted to, so why didn't they *keep* outside?

I informed her pedagogically that out of 500 odd species in Britain that made webs only five or so made them in houses. She asked why, and I explained that the dust and filth in a house very soon spoilt their wonderful creations. At this, for some reason, her lips tightened and she terminated the discussion on natural history abruptly.

But so it is, and the whole lot of the web weavers, the five or so inside ones and the 500 or so outside ones that we have here only amount to a small percentage of the spider world.

Since we (or rather the wasps) are shortly going to deal with spiders, perhaps we ought to sort them out and say a few words about them. There are five principal classes of spiders. (I am not using the word "class" in its scientific sense.) This classification is rough but extremely useful. It is based on their habits and mode of gaining a living, just as we once classed men as hunters, fishers, and the like.

(1) The Web Weavers. As all know, these snare their prey, and when it is snared and struggling to get away deal with it either by biting it and introducing a poison or by binding it with silken threads as ranchmen lassoo and rope a steer—or by both methods combined. They have eight eyes like nearly all spiders[1] but have almost lost the use of them. This is their own fault. Talents unused are always taken away: the other spiders have not made this mistake. But the web weavers have come to rely on their sense of touch, and that sense they have developed to an exquisite delicacy. Perhaps Nature has overwhelmed us with senses. She has given us five and I know of no form of life that *really* uses all these five. Often the one works against the other. A musician given five instruments is bound in the end to concentrate on one even though he may be able

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[1] Occasionally spiders are found with six and even with four eyes.

to play the others reasonably well. Most mammals concentrate on scent. Mankind has concentrated on eyesight and does not yet realise how marvellous his eyes are. Certain birds may excel him in some respects, but mankind has come to make his eyes serve almost his every purpose. The web weavers have sacrificed their sense of sight to that of touch. Having made their web they sit and see nothing, but the slightest quivering of the terminal threads gives them all the information they need.

(2) The Wolf Spiders. Most of the spiders you see scuttling over the ground in the vegetable garden are wolf spiders. They weave no webs—nor do any of the spiders in the other classes—but get their prey by running it down in the open. Hence, of course, the name. They are like wolves in every respect except that they do not hunt in packs. They have keen eyesight.

(3) The Crab Spiders. Many of this class have a sideways, crab-like motion, but this is the least interesting of their characteristics. They are artists in camouflage and seek places where, when they crouch down and lie still, they are indistinguishable from their surroundings. It is thus merely a question of waiting; and we are told that everything comes to him who knows how to wait. The crab spider knows how to wait very well, and judging by the fatness of most of them the game pays. It may be a bit boring, but then, alas, so are most ways of making a living. A favourite place of concealment is in flowers, the spider, needless to say, selecting flowers of similar colouring to itself. Some however go further than this. For instance, the species—often found in Britain—*Misumia valia* changes its colour. On leaves it becomes green; on yellow flowers yellow; and on white white. Experiments have shown that these spiders do not acquire the power of changing colour until they are mature, and, further, that when white and put on yellow paper they change to yellow in a period that varies from 24 hours to 20 days. When put

back on to white paper they change from yellow to white in 5 or 6 days. Camouflage is not their only trick. Some of them are mimics. There is one coloured a glaring white and grey and black that can sit on a green leaf in the open without any creature suspecting it is there. The reason is that it is exactly like the dropping of a bird. It cannot know this but must have found that by merely sitting quietly on a leaf and taking no precautions things just came along to be eaten.

(4) The Jumping Spiders. These jump at the fit and proper time, but a lot goes before the jumping. They are the sleuths of the spider world. The wolf spider, like a wolf, runs down its prey in the open: the jumping spider stalks it, creeps up, and then springs. On logs and railings, poles and gate-posts it marks its quarry and having done so gives us an exhibition of sleuthing that no Red Indian could hope to emulate. There is not much cover in many of the places where it operates, but even on a railing the slightest crevice or inequality serves. A real expert *can* do the seemingly impossible in the art of taking cover; a pheasant could almost hide itself on a linoleum floor. You have but to watch a jumping spider in action to see stalking brought to its highest pitch of perfection. Any one who has been abroad knows that a mosquito is sufficiently wide-awake, especially at night in a room with all the lights on. Yet I have seen a jumping spider, under these circumstances, and on a glossy painted cornice, stalk one, and get it. Its method is to go from point to point sometimes at an imperceptible crawl and sometimes in a lightning dash. At each stopping place it stays motionless for a space; then on again. At the correct distance it makes its jump. All this time, like some Alpine climber, it has trailed a length of rope. This rope is fastened down every few inches by the spider as it goes along. It is a kind of life line. If, when it jumps it overshoots it does not fall but swings from its rope and clambers back.

(5) The Trap Door Spiders. These are highly specialised.

There is only one representative in Britain and it has no trap door, only a tube with a fixed top. But you will find them in numbers in hotter countries. I once offsaddled near the Zambesi in a shady place, and lay resting. My eyes were fixed on a spot on the ground in one of those trance-like stares that are really self hypnotism. Gradually a little door opened in the earth and from the dark interior peered a little face. I lay quite still and a spider cautiously emerged. Intrigued, I moved my position to get a better view and it scuttled back like a flash and slammed the trap door after it. I got up and went to have a look. I had marked the place but could find nothing. It took me fully ten minutes to find the top of a brittle, earthy tube. When I tried gently to pull the door up I could not do so. So I crushed it and saw a spider run down a long hole. It had been holding the door down. I left it alone then; I have a fellow feeling for those who like their privacy.

So there are the five classes, but it must not be supposed that all act in the same way according to their class. The spider is an individualist. It knows nothing of the advantages —or disadvantages—of co-operation. That is why it has branched out in so many different ways. Even among the web-weavers no two species build the same kind of web, nor do all just sit and wait, for some make their web—or part of it—collapsible and use it like a bag or fishing net, holding and operating it themselves.

But the two most striking examples of originality come from the Wolf Spider class. The Water Spider (*Argyroneta aquatica*) has solved the problem of being air breathing and living under water at the same time. It swims and hunts in that medium by carrying its own atmosphere with it. On the surface, by means of a tricky flop and plunge it collects a globule of air about its middle—held there by hairs—and then goes down into the depths. When all this air is used up it is a simple matter to come to the surface and collect another globule. Its home, a shack made of hard silk at the bottom of the pond, it makes habitable by bringing down air globules imprisoned in its hind legs, pushing these under the door and thus displacing the water by air, just as the chemists fills his bell jar with some gas. This spider therefore was—by a long margin—the first discoverer of the "diving bell."

The Raft Spider, the large and handsome *Dolomides fimbriatus*, makes a raft on the shores of inland waters, seeming for some reason to be particularly fond of the Cambridge fens. The raft is made of leaves fastened with silk, and having made it the spider pushes off. It is not the kind of boat all would desire; it has no rudder and goes hither and thither as the wind dictates. Meanwhile Fimbriatus, the pirate, keeps a sharp look out and when he espies some rich prize—a fat emerging nymph for instance—springs from his vessel, runs over the surface of the water, and attacks at once. He returns in similar fashion and hauls his prey aboard the lugger. Then up anchor, as it were, and off again. Should *he* in his turn be threatened he is ready. He seems to have everything mapped out. At the first sight of one of those voracious Devil's-Darning-Needles, otherwise known as Dragon-flies, or other hostile craft, he adopts the tactics of the submarine and submerges just under the surface until danger has passed. As I have said before I can think of less interesting ways of earning a living.

All these new and sometimes startling ideas would have been quite impossible under the regime of the social insects.

Concerning the mating habits of spiders the general idea, I think, is that the female kills the male. This is not quite correct. The two often live in apparent harmony for months. Certain web-weaving spiders mate and live together, male and female, on or around the same web. That is not to say that the husband's life, even in these cases, is a good risk. Still, he often survives and, as I say, has several months' expectation of life. In the long run, it may be sooner or it may be later, he is bound to do something that aggravates his wife, even if it only be to bore her—which possibly is the worst crime he can commit. And a spider wife knows of only one method of dealing with a husband who aggravates her. Or she may grow hungry. The majority of spider husbands however do not live with their wives and in this respect are well advised.

We have studied the courtship of the cricket and the grasshopper, so we will follow that up with a few words about the courtship of spiders, though we can only go into the matter in a superficial way. Here again the spider's individualism makes it impossible to generalise. Few courtships are alike, but it can be said definitely and without equivocation that the male spider who goes courting is running considerable risk. Generally speaking he has four fences to get over. First, he must let the lady know—unequivocally—that it is a suitor who calls and not a fly ; next he must interest her in the suitor; then (if he has survived thus far) he must arouse her sexual desires and perform the sexual act; and after that he must go away. It is the last that is the most difficult. She is loath to let him go.

Often (unless some other spider has called immediately before him) the female is ready enough for his advances. Provided he plays his part and, by various methods that we shall touch on shortly, indicates his identity before they meet, he finds a female that is not only willing but eager to receive him. Indeed the stimulation and encouragement (after the introduction) often come from her, for female spiders are gluttonous in most of their appetites. But after that, the female, her desires in that direction at an end, may turn her thoughts to the edible qualities of her small though quite fat lover. This therefore is the danger time and only those males who make a prompt exit survive. Naturally, this only applies to those spiders that do not normally live for some time together.

The initial approach of the male to the female is made in an infinite variety of ways. Briefly, the web weaver males jerk on the web in a special way, in a sort of code, and the female as she sits delicately feeling the ends of her net recognises these jerkings as those of a suitor. Should she be feeling in the mood for love she minces forward; there is a gradual approach and touchings of legs and palpi. Would-be husbands of the Epeira, those portly females with short legs who are so much larger than their spouses that it is often difficult to believe the two are of the same species, must tread with exceeding care for their wives are pugnacious to a degree.

Many of the male crab spiders—that canny class—while making love to their lady, take the precaution at the same time to bind her unobtrusively with silken threads. When they have her sufficiently entangled they rope her up properly, accomplish their desires, and then walk away in complete safety. This seems to me the best method. Afterwards the female has often considerable difficulty in unroping herself.

Our friends the Peckhams studied very thoroughly the courting habits of the Jumping Spiders. We have seen the cricket charming the female by song: the Jumping Spider does it by dancing. Or tries to. His is a critical audience. It is advisable for him to know his steps. The Peckhams saw two males killed by a female before they had even taken the floor and when, as the Peckhams said, they had only offered her the merest civilities; the preliminary bow as it were that all polite dancers should make to those they hope will be their partners. *If* the performance meets with the approval of the dancing mistress she will partner him and the two will whirl round madly and crazily in each other's arms.

The Wolf Spiders (like the rest) have no fixed plan of campaign. Several strike attitudes and (if they have them) exhibit hairy adornments on their persons. Some stand at a distance and semaphore, using the ruffs at the ends of their palpi as flags.

The courting habits of the Water Spider, already mentioned, must be described. One grows a little tired of these bullying females and likes to see them getting a dose themselves of the punishment they are so ready to inflict on the male. Generally this is impossible; they are so much larger and more powerful. But the male *Arhyroneta aquatica*, alone amongst the spiders, is larger than the female. She has her under water house, you will remember, and when spring prompts the male to go wooing he builds a house close to hers. Having filled his house with air he constructs a corridor joining the two houses. She, meanwhile, is ignorant of his designs and operations and the first thing she knows about them is when he breaks down her wall and enters, the air pockets of the two houses uniting through the corridor.

The tender emotions, or at any rate the carnal desires, are not, as we know, altogether absent from the female spider's breast, but they need awakening. They must not be taken for granted. And the way to awaken these emotions is not by breaking into her carefully built house and letting in a lot of cold water. So it is usually no responsive female that the male Water Spider meets after his daring entry. He needs all his extra weight to hold off her violent attack, and by the time he has subdued her there is often little but wreckage left both of the houses and the corridor.

But water spiders hardly concern us in this book, and are definitely of no interest to any wasp.

When spider hunters are mentioned, Pompilus always comes first to mind. One almost forgets the rest, though they are many. Pompilus belongs to a family of spider hunters called Pompilidae, which includes the British genera of Priocnemis, Calicurgus, Agenia, and Aropalis. How many species are attached to them I could not say; a large number, and all of them a menace to spiders. Pompilus, the most famous of the family, dresses as a rule in jet black with a red waist-band, and of all the hunting wasps is the most tempestuous and excitable —which is saying much. Sphex, that dasher to and fro, becomes a sedate lady by comparison. When Pompilus has got her spider she has to keep putting it down in order to jump with glee, and merely to watch the feverish activity of her nest making is enough to give any one a severe headache. If British builders worked like that there would be no housing shortage in Britain. Perhaps I am wrong; our climate is not a sunny one, and for all her fevered activity the slightest hint of a wispish cloud over the sun is enough to make Pompilus knock off. It is as if she converted the sun's rays directly into energy without possessing storage batteries.

In spite of her impetuosity she is a skilled vivisectress. Pathetic indeed looks the spider after she has had an interview with it. I suppose one ought to feel no pity for a spider. It is the female that is usually selected, and she herself is clever enough in the art of torture. But nothing *she* can do to her victims compares with what happens to herself after she has been selected by Pompilus. So in spite of her own cruelty, and in spite of the dog's life she leads her husband, I feel sorry for this fat thing when I see her so limp and dangling. After all, spiders do *us* no harm—and that counts for much, more indeed than many are prepared to admit—while farmers (if not their wives) are convinced that they are highly beneficial.

But surely, you will say, spiders are not without the means of defending themselves. Have they not poisoned fangs? Can they not do a bit of paralysing themselves? Do they not bite their victims with the skill even of the hunting wasps? Possessing a weapon do they submit tamely to the hypodermic needle? The answer is yes . . . and no. Like so many sadistic bullies the lady spider is a bit of a craven when confronted by something she cannot intimidate. In addition, there are many sorts of spiders. A wolf spider, for instance, is a different proposition from a web weaving spider; the latter can be aggressive enough on her own snare or in the doorway of her own house, but apart from these familiar surroundings she is at a loss, whereas the wolf is accustomed to hunting and fighting in the open, and few have keener eyes. Also the spider has that unfortunate propensity to sham death. When in doubt, she argues, pretend to be a corpse. I suppose the scheme works at times. It must do. But it does not help her with the avenging housewife, nor with the hunting wasp. On the whole I think it would be better if she unlearnt that trick. I think, it does her a lot more harm than good—especially with Pompilus, for the spider's weapon is quite as deadly as that of the wasp and the latter is usually several times smaller than her intended victim.

Of course, the wasp can fly: she can use her wings to dodge and get out of reach, and on her wings she can descend and attack from any quarter. This gives her an unfair advantage. What happens when the wasp cannot do this? We might as well look into that matter now and ask the naturalist, Oswald H. Latter to demonstrate.

He arranged a ring. There was plenty of floor space but there was a glass top so that the wasp could not fly. There were no rounds, no seconds, and the only referee was the naturalist. It was one of those very primitive fights and Mr. Latter watched it all by himself. He put a fresh spider in the ring and a female Pompilus and sounded the gong. What surprises me is that the spider did not double up immediately and say it was dead and allow itself to be counted out. But it did not; it pulled itself together and faced the wasp " tense and on tip-toe." Pompilus started the proceedings by a feint with her abdomen which the spider side-stepped. The spider then lunged quickly forward and got in a very crisp one. And that was that. Pompilus fell over on her side, the referee presumably counted ten, and no one was more surprised than the victor. The dead body of the wasp was then removed but we are not told what happened to the spider.

It was an interesting fight in some ways because the one was armed behind and the other in front, but it was definitely unfair to Pompilus, who was not only ill-equipped for a fight confined to the land, but had had no training for it. For these

Pompili, it seems, *do* train. Latter and others have witnessed it. They fight often enough over booty, but they train too. One would be inclined to put it down to a difference of opinion, a kind of showing of fists, but Latter says no. He says it is training for spider hunting, so whilst he is still here we might as well ask him to describe it; it will not take long.

"Two females settle down face to face on a patch of sand; they move round and round as though searching for an opportunity to lean over first on one side and then on the other side, and from time to time lash round with their wonderfully flexible abdomens as though delivering a stab from the venomous sting."

So there it is. I still have my doubts. I cannot quite see the object of sparring with someone armed behind to train for a fight with someone armed in front. But I have never seen it so am not in a position to pass an opinion.

Pompilus nests in the earth or in holes in a wall. Some make their nests first and then capture their spider, but the majority capture the spider and make their nest afterwards in the nearest suitable spot. They store only one spider in each nest and most of them are not at all particular as to its variety. They usually choose prey considerably larger than themselves and experience great difficulty in dragging it along. In fact, the journey home in most cases is an epic affair, a struggle against terrific odds.

We will select one Pompilus and mention a few of the things that may happen to her and a few of the things she may do. Having paralysed the spider (we will go into that later) she seizes it by one leg and hauls and tugs at it, working her wings as additional motive power. Progress is of the inch by inch variety; sweating, struggling, pulling, straining inches. Herbage gets in her way and frequently blocks the path of her bulky load so that detours must be made. If only she could fly! That thought occurs to her too, and seeing a tall stem she often makes for it, even though it entails a lengthy divergence from her path. Arriving at its base she probably drops her spider and skips round it in glee at the thought of shortly being airborne. What follows is the sort of act clowns give at a circus. Going backwards she pulls the spider up the stem until a side shoot gets in her way. Trying to get round it, she drops the spider. She goes down after it and the climb begins again. At the next obstruction they both fall to the ground together. And so on, time and again. Were she really trying to clown, the average critic would say that she overdid it. One has to keep reminding oneself that this is deadly earnestness, and that, for her, each fall is a minor tragedy.

Sooner or later, generally later, she arrives at a point that she very wisely considers is high enough, and takes off. The flight is a short one. Weighted by her spider it is merely a planing to earth on a par with that of a small model aeroplane thrown from an upper window, and sometimes as abrupt. I don't deny that she covers some ground by air, but taking everything into consideration I think the overland journey would prove the quicker. But that is her affair, and it will not stop her making another aside and reaching another tall plant and having another go.

The nest gets close. You can tell that from her behaviour. Just as she jumped with joy because she had killed a spider, now she keeps jumping with joy because her nest is getting close. Like Sphex, a desire to see it comes over her. She leaves the spider and goes home. She digs and finds no home and registers despair by dashing distractedly around and burrowing everywhere. She finds it and registers delight. Back to the spider, but the spider has gone. You can almost hear her sobbing as she searches. Finding it (where she left it) she skips about with joy. She hauls again and the act is repeated several times. Sooner or later she stops suddenly and looks at the spider's legs. A spider *has* a lot of legs and they stick out rather. She notes this with anguish and attacks them at once, biting at them where they join the body. One, rarely more, *may* come off, but her work is probably not wasted: although the legs—or most of them—remain, their chewed-up bases will be easier to fold when the time comes to pull the body through the aperture.

Getting still nearer home one of her many inspections will convince her that the spider *is* too large and that extensive alterations will be required. Mercurial as she is, she is not without sense: indeed, underneath the boiling surface is brain in plenty, and she realises that alterations such as she proposes to make will take time and that ants are ubiquitous and love spider meat. So for all her hurry she drags her spider up a plant and lodges it in a fork of the stem. Here, though not immune from ants, her prey is in a position where they are unlikely to find it before she returns. A leopard does the same thing with *its* prey and caches it in the fork of a tree. This hiding of the spider high up on a plant is more common with those wasps who make their nests after, and not before, the kill.

There will be trouble at the nest mouth of course; a lot of pulling and straining and enlarging and sorrow and joy; but she will get it in somehow and lay her egg on it and come out. It is over, one would say; all she has striven and worked so hard for has now been accomplished. But Pompilus is as frenziedly busy as ever. The nest must be closed. Careful and artistic as was Ammophila, Pompilus is even more so. The aperture is blocked with sand and all loose stuff swept completely away. Bits of earth, leaves, pellets of rabbit dung, are brought and, in spite of her haste, placed down in careful disorder. Stones are dug out, and for each one brought several will be madly tugged at and abandoned. When she has finished, on that bit of earth there will be no trace at all of any blocked-up nest. There never was to you or me but she is working for keener eyes than ours. She goes off now to make another nest and get another spider and have another baby.

This is a short picture of what happens when things go well, though it omits a number of side shows very irritating to an observer. For Pompilus will often hide her spider in twenty different places, changing her mind as many times. She will drag it into a crevice and stay there half an hour or longer as if it were her nest, only to reappear and drag it to another crevice and do the same thing there. But things do not always go well. Sister Pompili will rob her even at the end of her toilsome journey. The nest is often lost completely, necessitating the making of another (which for some reason entails about five being started, more or less completed, and then discarded). The spider also is often lost. And one poor Pompilus was observed to drag a very large and very fat one a long distance only to realise when completely exhausted that the feat was beyond her strength and with many long sorrowful backward glances, go slowly away.

The Peckhams made several efforts to dig out the spider after Pompilus had interred it—in order to find out if it was lively. They could never find the nest, nor the tunnel, nor, strangely enough, the spider, even after they had lost patience and dug up all around and sifted the soil. So they inserted a fine blade of grass before Pompilus had filled in her hole. The scheme was good in its way, but Pompilus did not like it. Having ignored them before she changed her attitude when they began to meddle in her affairs and adopted what they called "a most comically threatening attitude," whirling and circling about them, after which she pulled the grass out and took it away. They put it back again and she pulled it out again. When they did it a third time she abandoned the nest and flew away to make another in some place free from interfering busybodies.

Robbery is fairly common. A Pompilus will see a sister taking home a spider and like the look of it. Probably she has just lost her own. So she follows and when the sister drops the spider, grabs it. A fight ensues, the two rolling over and over. It is, it must be granted, a very different sort of affair from the one Latter describes when two females circle round each other feinting with their abdomens; it is more like two small boys rolling on the ground and punching each other. The sting in these rough and tumbles is never used, for the hunting wasps do not regard their sting as a weapon either of aggression or defence. Nor would two of *our* surgeons, were they to fight over a patient, attack each other with their hypodermic syringes. The thief often manages to hold the other off and get to her nest with the stolen property. She wastes no time then in the usual preliminaries but gets inside as quickly as she can—provided she can get the spider through the hole.

The *bête noire* of Pompilus is the ant. Ants are fond of spiders (when they are dead or incapacitated, not otherwise) and will eat not only those temporarily abandoned by Pompilus, but those stored in her nests, which they reach by digging through the sand. An observer saw a spider left lying on the ground approached by a red ant of almost microscopic proportions. The owner, who was close by enlarging the aperture of her nest, caught sight of it and rushed back in wild rage. She seized the creature in her mouth and flung it violently several times against the tip of her abdomen, after which treatment the ant trotted home and the wasp, still trembling with indignation, pulled the spider up the tallest plant it could find and lodged it there.

It was the great ambition of the Peckhams, of course, to see Pompilus make a kill. We know Fabre's method; how he got understudies and substituted them for the paralysed prey while the wasp was not looking. The Peckhams decided to adopt this plan too, especially since both Pompilus and the spider lend themselves admirably to the deception. The wasp leaves its prey, often for long intervals and the spider, even when fresh and unhurt—in fact, especially when in that condition—is the most conscientious of all understudies. Its trick of shamming death—on the wisdom of which I have already cast doubt—when anything out of the ordinary happens, makes it an invaluable collaborator. To be, as it thinks, on the safe side, it stays where it is put and in imitating death also imitates to the life (if that is the right word) paralysis.

The Peckhams saw a Pompilus (*quinquenotatus*) hang up a spider (*Epeira strix*) on top of some purslain and go off to her nest. By a bit of luck the Peckhams had a spare *Epeira strix* and made the exchange. The fresh one played its part to perfection and looked just as paralysed as the other, if not more so. Back came Pompilus, went straight to it—and immediately began to hunt for her own spider. There was not even an inspection of the property of the Peckhams. It was as if it did not exist. The wasp thought her spider must have fallen and went to the foot of the plant and searched on the ground. Then she thought she must have mistaken one purslain plant for another and went up several more, looking at their tops. After five minutes she gave it up and flew away.

How did she know this was not her spider? The Peckhams never solved the problem. The thought occurred to them that since they had handled their own spider quite a bit, Pompilus had refused it on that account; that their smell perhaps remained. So the next time they came upon a paralysed spider hung up and waiting they took it and handled it and put it back, and when the wasp returned it was taken to the nest without any objection.

One remembers a similar disappointment Fabre had with a grasshopper, which was refused, as he found out later, because it was a male. The Peckhams do not say whether their spider was male or female, but since the female is so much larger than the male they could hardly have made this mistake.

Their next experiment was made with the same wasp and the same spider, which they had collected and put back in its box. They knew that the wasp's nest was close by and they assumed that she would come back with another spider. She did, and hung it up on a beanstalk. What went on in her mind it is difficult to say. She seemed a peculiar wasp altogether. She went to her nest, which was now made and ready, and decided she did not like it and started to make another one close by. The Peckhams could therefore make the substitution at their leisure. The understudy, however, who had done so well before, got restive. The wasp was quite a long time making her new nest and the spider became bored. It decided that the All Clear had sounded. The Peckhams tried to make it readjust this impression and kept it quiet for short periods by smacking it with grass stems, but in spite of this it threatened to walk out on them at any moment.

And indeed it was half-way down the beanstalk when Pompilus came hurrying back, her new nest ready. She saw the spider and hovered over it—and the spider needed no smacking now to make it stay put. But Pompilus, as before, paid little attention to it and started to look for her own spider. When she returned the Peckham spider, now at the base of the beanstalk, came to another abrupt stop. This time it was examined with some care, though never actually touched. This inspection merely confirmed the wasp's previous conviction. She also decided that there were things going on that she did not like and flew off and did not return, though Mr. and Mrs. Peckham and the spider waited for her a long time.

It sounds incredible, but that long-suffering spider was called upon for yet a third act. By chance, combined with good eyesight, the Peckhams espied a paralysed *strix* hanging on a plant and knew that some Pompilus would shortly call to collect it. So out came our friend to take its place. Luckily the wasp came back soon, before the now famous understudy could disgrace itself again. But the same thing happened as before. This new wasp also ignored the actor and hunted frenziedly for her lost property. So evidently the fiasco was not due to some idiosyncracy on the part of the first wasp. No blame either can be attached to the spider, for later in the season the Peckhams tried the same act with several other spiders of the same species. Indeed, on occasions they actually pushed strixes under wasps' noses but got no response.

One is glad to hear that the original spider was taken after *his* third performance to a secluded part of the garden and there released.

The Peckhams did at last see a kill, though it left them little wiser than they were before concerning the *modus operandi*. Strolling in the vegetable garden on a September day they came to the bean allotment and halted, filled with wonder and delight. This enthusiasm was not caused by the beans but by a large Lycosid running and dodging here and there for no apparent reason. Now a Lycosid is a wolf spider, no mean hunter itself. Up above, equally excited, was a Pompilus that dashed down repeatedly at the spider whenever a clear space allowed her to do so. She would pounce and miss, and once she pounced and got it, but was shaken off by the stronger animal. Then came a pounce in which she got a better grip, and the two went rolling and twisting over the ground. They were so mixed up that all that could be seen was the flashing red waist-band of the killer. Then Pompilus arose leaving a motionless spider on its back on the ground and hovered above it watching the effect of the injection she had given. It is quite obvious that in a tussle like this with an opponent not only armed but also stronger than herself any selection of nervous ganglia by the wasp is impossible. It behoves Pompilus to use her stiletto anywhere, and use it quickly. Smaller spiders can be, and are, gripped and held down and subjected to expert treatment. That this Pompilus had no delusions on the matter was shown by her cautious approach when she alighted and by the fact that the first thing she did was gingerly to examine the spider's mouth, where the poison fangs lie. She was taking no chances, for her stab had been at random. Only after assuring herself that her drug had acted and that the fangs were out of action did she seize the spider and drag if off.

If necessary the spider is laid down and stung again on the journey. This has been observed and can also be inferred from that fact that the spider is always in a state of complete collapse when stored. Even the Peckhams could find no trace of what they would call "liveliness" in the many stung samples they examined. They found some that were dead—probably large ones killed in that first scuffle where no marksmanship is possible, and others that lived for varying periods from a day to forty days in a state of inertia.

It is quite remarkable how these murderesses inflicting as they do the most protracted suffering on their victims, infatuate those who get to know them. Mrs. Peckham, for instance, judging from what she wrote, would have liked to kiss them had that feat been possible. And others who have studied this temperamental insect have felt the same fascination. It bursts out in the writings of most of them however much they try to control it. All the hunting wasps, bloodstained to the eyebrows though they are, have that effect. Listen to Fabre, talking about Spheges, and then dare to tell me that hunting wasps have not got personality.

"O my pretty Sphex-wasps," says Fabre, " fly away without fear of my tubes, my boxes, my bottles, or any of my receptacles." (He is talking, incidentally, about Spheges he has brought up himself from the chrysalis.) "Go, but beware of the Praying Mantis who is plotting your ruin, and mind the lizard who is lying in wait for you. Go in peace. Dig your burrows, stab your crickets scientifically and continue your kind, to procure one day for others what you have given me: the few moments of happiness of my life."

This brings to mind another incident connected with Spheges. Fabre was watching a Sphex's nest. At that time he was not the famous, the "incomparable" observer he afterwards became; he was merely a schoolmaster on holiday, spending this holiday, as he always did spend his holidays, studying some insect. He had discovered a Sphex's nest at the edge of a beaten footpath and, having seen the Sphex go in, was kneeling by the nest waiting for it to come out. Looking up for a moment he saw two conscripts approaching. There was of course some danger of one or another of them treading on the nest with a great ammunition boot. The obvious course was to warn them, or even just to motion them aside. Fabre could not do this. He feared they might be curious and stand by and watch what he was doing, and no doubt giggle to each other. He got up and pretended to be interested in the scenery. He wanted them to pass by and go away. He took the chance. It was most unlikely that one of them *would* tread on that particular spot. So he stood and gazed the other way—watching their feet out of the corner of one eye. Alas, a heavy nailed boot planted itself fair and square on the nest. "A shudder," says Fabre, "ran through me as though I myself had received the impress of the hobnailed sole."

Spheges apparently were Fabre's weakness. Each hunting wasp seems to have its own particular admirer. Alas, Crabro, the most worthy of them all, has none, so far as I can discover.

Fabre devoted much attention to the Pompilus family, and like most other observers he dearly loved to stage a fight. We have already been present at many shows produced under his management, but so far they have been rather one-sided. Presumably the wasp desired them so; presumably she is out for meat, not sport—though why the whole lot of them have not confined themselves to caterpillars is hard to understand: there are ample to go round (ask any gardener), they present next to no opposition, they cannot run away, their skin is penetrable in any part, and they are good food for infants. But for some reason many wasps have selected more difficult subjects. This makes these wasps more interesting from our point of view. To see butcheresses killing helpless sheep, however expertly, begins to pall. So it is with a quickening of interest that we see them preparing to knife animals better able to defend themselves. And at first we watch the fight eagerly, but really it is the same thing; the knifing must be more precise and the struggling victim may be more difficult to hold down, but the prey, even the bee, is usually an inoffensive creature that never deals death itself except in self-defence.

I do not say that Fabre became bored with seeing his wasps kill their victims. Fabre could no more be bored by an insect than a love-sick swain by his mistress, but when he saw a Ringed Calicurgus (the Calicurgus, you will remember, is of the Pompilus family) dragging an inert Black-Bellied Tarantula by one leg there is no doubt that he stiffened with excitement. For the Black-Bellied Tarantula is an ogre amongst spiders, all of whom to a greater or lesser degree are ogres too. Its deadly fangs can kill a mole or a sparrow with one bite. And if this meticulous observer got as much anticipatory delight as Romans did when Nero got a new consignment of lions and tigers, who shall blame him? He deserved it. All I have to do, he said to himself, is to get a supply of Black-Bellied Tarantulas and of Ringed Calicurgi and I shall be able to watch a dozen Homeric contests in which this noble wasp slays its formidable opponent. I shall see its method. And what a method it will have to be!

It was not one battle between David and Goliath that he proposed to present to himself, but several score. So he began collecting. Of Goliaths there was no lack, but Davids were in short supply. He had the one that he had intercepted dragging the Tarantula, and the next day he caught another that was lost in meditation on some blue flowers, but that was his total. And quite enough, he argued. For since the Ringed Calicurgus is the victor, these two could be used again and again, and their methods studied to the very last degree.

For the performances he got two bell glasses and into each introduced a Pompilus and a Black-Bellied Tarantula. His eyes were agleam with excitement. In his own words: "What a tragedy there will be in a moment!" And he was right—but the tragedy was his, not the spider's. For you can lead a horse to the water but you cannot make him drink. Similarly, you can put two pugilists in a ring but you cannot make them fight.

One feels sorry for Fabre. He had gone to a lot of trouble, and though he kept his seat at the ring-side for over a week never a fight did he see. The Pompilus stalked round the perimeter of the bell-jar in a worried way and the spider stood disconsolately in the middle. Pompilus then noticed the spider and, possibly blaming it for her imprisonment, made to seize it by a leg. But when the spider reared itself on four legs and, showing its fangs, prepared for battle, second thoughts prevailed and Pompilus resumed her orbit and the spider its melancholy stance.

Round and round, backwards and forwards, went Pompilus until the spider could stand this restless pacing no longer and flung himself upon her. Fabre smiled happily. Surely now, he thought, the BIG FIGHT will take place. But though there was a struggle of a half-hearted nature nothing drastic happened. For some inexplicable reason the wasp did not use her sting nor the spider its fangs. They mauled each other and after that the wasp disengaged herself and returned unscathed to her circular tour.

It was strange. I can understand the wasp: she had put all thoughts of hunting and killing out of her mind; all she worried about was getting out of the glass trap. But why the spider, having gone to the length of making an attack and seizing its fellow prisoner, should have withheld the death bite I cannot make out. It was certainly not due to pity for a weaker foe—the word pity has yet to be entered in the Arachnid dictionary. Whatever the reason, it was surely foolish of the spider not to take this unusual opportunity of getting rid of one of its most dangerous enemies.

Several times was this mauling of Pompilus by the spider repeated, and each time Pompilus managed to break away, bruised no doubt but not seriously hurt. She showed no fear and was unperturbed—for Pompilus comes of a proud race that carry their heads high.

Fabre thought that perhaps conditions had not been sufficiently natural. A bell-jar on a study table *is* a little severe. So he fixed up a larger arena with a gauze ceiling and with soil at the bottom and he made a little castle for the spider, and for the wasp he arranged flowers besmeared with honey, while for the spider's sustenance locusts were provided. Now, he thought, the two will feel so happy and comfortable that they are bound to fight. But they did not. The wasp ate the honey and the spider munched her locusts. The castle was used by both in turns, evidently by tacit agreement. Sometimes the spider stood up and waved the wasp on like a policeman when she came too close, a gesture that the wasp obeyed in an understanding way. Indeed, what had been arranged as a gladiatorial show became perilously akin to one of those so-called "Happy Families" seen at fairs where various ill-assorted creatures live in a cage without killing each other.

Infinite patience goes to the make-up of a naturalist and Fabre had no intention of calling himself beaten. A fight he wanted, and a fight he was going to have. He decided to imprison his two Calicurgi on the natural threshold of an untouched Black-Bellied Tarantula. So he went off to the fields with his two weary candidates and amongst some pebbles in some thyme found the burrow of a Black-Bellied Tarantula, complete with occupant.

It seems to me that the time had come to change the other parties also. It is the urge of the unborn egg that makes hunting wasps fight and these two had long ago relinquished, or at any rate postponed, all thoughts of an accouchement. What they wanted was to get out of the glass walls of their prisons. But Fabre, the fight-promoter, was unrelenting. He fixed his new open-air arena over the cavern of the Tarantula and popped in one of his Calicurgi.

She travelled as usual all round the gauze ceiling, while from the dark hole below the observer could see the glittering eyes of the spider watching her. Since the wasp seemed determined to stay on the roof and to ignore the spider's shaft Fabre brought her to earth by replacing his bell-jar, the sides of which she could not climb. Complete success followed. The wasp saw the dark chasm and went straight down. This was beyond all Fabre's expectations. He rubbed his hands. He had never thought that the wasp would be bold or rash enough to tackle the spider *inside* its lair. Buzzings and subterranean noises announced that the two had met. Fabre had a sort of bet with himself which of them would emerge showing itself the victor and leaving its dying opponent in the cellar.

It was the spider; and a spider tumbling with indignation. It posted itself at the entrance of its home ready to deal with the intruder when she came out. And in due course the intruder did come out and as soon as she showed herself received a cuff which knocked her sideways. The spider then went back to its cavern doubtless believing that it had taught that particular wasp a lesson. It deceived itself; the wasp went down three more times (in search of an escape from prison, I suppose) and each time she went down the spider rushed out and stationed itself where it could best give her a crisp buffet as she emerged. After the third descent Pompilus entered the burrow no more. Either she was convinced that no path to liberty led therefrom or she was tired of being knocked for six every time she came out.

The other Calicurgus gave no better results.

One would have thought that by now Fabre had had enough. But for three weeks he kept the two wasps, each partnered with a Black-Bellied Tarantula, in his study, only to find that the faint hostility displayed at first gradually gave place to a spirit of forbearance. Only the death of both wasps from natural causes—their span of life having reached its alloted end—may have prevented this spirit from ripening into affection. Fabre, I regret to say, was not impressed by the edifying scene. "A pitiful end," he called it, "after such an enthusiastic beginning."

Those who imagine that he will now discontinue this particular experiment do not know the man at all. The whole idea is a bit crazy—though it *does* succeed at times. You cannot expect an insect—or anything else—to pursue its normal course under artificial and frightening conditions. If a giant snatched up two well-known pugilists, the one—shall we say—when he was catching a bus and the other when he was hurrying home and put them in a bottle, he would have little chance of learning the finer arts of boxing. Fabre kept his pugilists in the bottle until they died and was annoyed at the lack of result. But at their death he says, "Shall I abandon the problem? Not a bit of it. Fortune favours the persevering."

And Fortune did. The odds were about one in a thousand against success even if Calicurgi had been plentiful. Actually it was quite an event for him to meet one; that is why he had hung on to those first two so long after they had proved their unfitness for the ring. Yet a fortnight after their death he met another Calicurgus. This was not the same Black-Bellied Tarantula hunting species but another, the Harlequin Calicurgus, in other words, *Calicurgus scurra*, a brightly coloured lady of about the same size.

He did not know which spider she liked best, and though he does not say so I think, for all his perseverance, he was not going to invite more disappointment by trying the Black-Bellied Tarantula any more. He chose a Banded Epeira, the largest spider in the district after the Black-Bellied Tarantula. Now he does not mention it but this is a web-weaving spider while the Black-Bellied Tarantula is a wolf spider. Epeira or garden spiders are fierce and cruel enough to creatures ensnared in their nets, but in fighting qualities, as we know, there is a world of difference between them and the wolf spiders. The latter are active and keen-eyed and get their prey by running it down and often fighting it; the Epeira are fat, sedentary, and almost blind.

Even so, this Epeira made a show; she got up on her hind legs just like the Tarantula and assumed the same intimidating attitude. But in a second she was on her back, her bloated stomach sticking helpless in the air, the wasp astride of her. This is where Fabre was all eyes. He wanted to see where the wasp would strike. Into the concentration of nervous ganglia in the breast, he presumed, but instead the sting went straight into the mouth. *After* that the breast was pierced and the spider laid low in perpetual paralysis, except for a few unimportant twitchings.

And very carefully did the wasp examine the fangs before she took any further steps. I need not enlarge on this. It was exceedingly clever of the wasp. And yet, the obvious proceeding. If you wish to incapacitate any one carrying a weapon you must strike first at the member that has it. You can then proceed with less danger to yourself. And without its poisonous fangs the spider is not of much account. So Fabre says now that he is quite satisfied. Obviously, he says, this is how the other Calicurgus deals with the Black-Bellied Tarantula. It is all proved. And yet I wish that other fight *had* come off. What I want to know is how the Calicurgus gets the Tarantula into a position to sting it in the mouth. The fact remains of course that the Calicurgus *does* overcome the Tarantula somehow. I expect she relies on her wings and on unfettered air movement. After all, we cannot gauge the capabilities of a Spitfire by watching its manœuvres whilst taxiing along the ground.

Where Fabre was so lucky was in this wasp attacking at all. He tried again time after time with the same subjects—the Harlequin Calicurgus and the Banded Epeira—with no result. I think in the first case the wasp never realised it was imprisoned; it saw the spider and went for it before that fact sank home. On the whole it was a pity, for it caused Fabre to waste a lot of valuable time studying various huntresses with their prospective prey under glass without success. Not only the spider hunters but others, the Speges, the Cerceri, the Bembeces, the Eumenes, the Tachytes; one and all refused to play their part when under his bell-jars. One can be too persistent.

In the end Fabre *was* able to study Pompilus hunting under natural conditions. It took him years, but at last he saw a hunt in progress. The huntress was neither the Ringed Calicurgus nor the Harlequin but a smaller and less conspicuous cousin, an all-black wasp about the size of the hive bee, named *Pompilus apicalis*. Her quarry was the "Black," or "Cellar" spider, *Segestria perfidia*, common in France but unknown, I think, in Britain.

Now this Segestria, although a web weaver, is hot stuff. She is much larger than Pompilus and she makes short work of quite large flies such as drone flies. She is even credited with overpowering the common wasp, though this I doubt. The common wasp is lithe and strong and active. It is also game and fights to the last. So many spiders have been credited with the ability to overcome wasps that one grows sceptical. Put a common wasp into a spider's web yourself and see the result. Wasps *are* caught in webs but I think as a rule they were exhausted or half-comatose when they got in. Anyway, this Segestria is not exactly a pet and its bite will raise weals on a man's wrist. It lives about old walls, generally in large numbers, and it spins a funnel-shaped web the small end of which terminates in a hole in the masonry, where the spider crouches. Farther inside is a little cellar to which the spider takes her prey to eat or store. Segestria's method is to sit half in and half out of her narrowed funnel. Two legs squat inside the hole and the other six rest on the terminal threads of the web. Here, like the thumb and forefinger of the wet fly fisherman as he holds the line, they perceive, the slightest vibration or "strike" on the web in front, and when this strike is felt the spider hurls herself out to attend to the intruder.

Evidently she relies on her web only as a temporary measure, to detain rather than to hold a visitor until she arrives to deal with it in person and sink her poisoned fangs where they will do most good.

And into this formidable barrage of funnel-shaped webs and grim ogresses comes *Pompilus apicalis*, running, leaping, flying, flapping her wings and examining every crevice. The various threads do not impede her; she steps lightly on and over them. In common with the spider herself she possesses the secret of treading on a web without getting stuck.

Quite soon she comes upon a crevice where a spider lurks. The spider does not cower further into its recess; it comes out and raising itself on its two hind legs shows its murderous fangs. This is usually enough for Pompilus: she withdraws and the spider retires indoors, or rather half indoors. And from every funnel that is inhabited the same threatening form appears. In one instance it does more; a spider leaves her crevice and hurls herself at the wasp. Pompilus flees only just in time and the spider goes back.

This is hardly a picture of a butcheress selecting her victim for the knife. Yet it is all that Fabre saw for weeks and weeks; just a number of Pompili fluttering around and running away every few minutes from annoyed spiders. He began to wonder who was the attacker and who the attacked—which the butcher and which the sheep.

Then he saw a Pompilus make a sudden dash at a spider and seize her by a leg. With an angry shake the spider tore free and the wasp fled before the spider could get her. She tried other spiders then, all of whom came to meet her standing half-out of their burrows and offering six legs. Always Pompilus was repulsed after seizing a leg, though once she dragged a spider a few inches from its burrow before it shook itself clear.

Then came success. With a sudden vigorous tug Pompilus brought a spider tumbling to the ground. Away from its stronghold and demoralised by its fall the spider was no longer the aggressive creature it had been. It cowered to the ground and drew its legs together, preparatory I suppose to shamming death. It had not time to do so before the real article—or rather something infinitely worse—came upon it and Pompilus's lancet flashed into its breast.

It is the old old story; if only the spider would maintain its defiance all would be well and it—at least the larger ones—need have no fear of hunting-wasps. But the hunting-wasps have sensed the yellow in the spider's make-up so that now it is permanently on their menu. But *Pompilus apicalis* certainly would appear to have to work longer and harder for her baby's food than her American relatives, and to undergo a considerable amount of risk.

Pompilus apicalis, like the Ringed Calicurgus, does not make her own burrow. She appropriates that of the spider. So having paralysed her prey she searches the wall for some cranny and investigates, with her usual fuss, unoccupied silken tubes. Having found one she returns and drags her spider after her, often pulling it up the face of the wall. Into the chosen burrow it is pushed and the egg laid on it; a snug, soft, silk cushioned retreat for the coming grub and chrysalis. The spider therefore constructs her own torture chamber and probably it is not the first time this chamber has seen dark and horrible deeds. The closing of the nursery completely lacks the care and neatness and tidiness shown by so many of her relatives: bits of mortar are found, stuffed in—and the job is done.

In showing us the hunting methods of this Pompilus, Fabre cannot resist a gibe at the "evolutionists." He will not have it that an insect can acquire any trick that it can pass on to posterity—though how their tricks originated in the first instance he never explains. "I will admit," he says to us, "that the wasp may gradually have acquired, as being highly beneficial to her posterity, the instinct by which she first of all so judiciously drags the victim from its refuge, in order there to paralyse it without incurring danger, provided that you will explain why the Segestria, possessing an intellect no less gifted than that of the Pompilus, does not yet know how to counteract the trick of which she has so long been the victim."

This sounds a fair enough offer at first sight but it does not bear examination. Firstly, five spiders out of six *do* counteract the trick; the tactics of the wasp fail to dislodge them and they remain, complete mistresses of the situation. Secondly, although the capture of a spider is a necessity for the Pompilus, an act essential for the continuance of its race, failure on the spider's part to avoid capture by those who do fail—only amounts, so far as the race is concerned, to a few casualties. The majority of Segestria never see a *Pompilus apicalis* and are in no danger from her so that one can hardly expect the whole race to acquire an hereditary ability to fight a foe whom most of their ancestors have never met. And lastly the question is a little foolish, for if Segestria *had* learnt to counteract that trick we should have known nothing about it and the wasp would now be trying either another spider or another trick. What goes on now tells us nothing about what may have happened before.

What Fabre complains of is the aggressive attitude of the spider when it stands at its burrow. It is doubtless very brave of it, he says, but it is very foolish to show a leg that the wasp can seize. He thinks it ought to cower in its burrow. And yet he has said elsewhere that if large spiders, with their formidable armament, could only learn to face up to wasps, wasps would have to leave them alone. No, where the danger lies to Segestria is not in its boldness at its front door but in its cowardice when tumbled to the ground. For the Pompili have little to learn about psychology and anticipate and count on fear overcoming the spider when dislodged from its castle.

Fabre in another paper asks the same question about the bee killed by Philanthus. He certainly hammers his points home. "If," he says, "the one has learnt by prolonged practice in attack, the other should also have learnt by prolonged practice in defence, for attack and defence possess a like merit in the fight for life. Among the theorists is there one clear-sighted enough to solve the riddle for us?"

Do I flatter myself? Does not the same explanation suffice? Hives in certain parts are plagued by the Philanthus and many no doubt have been exterminated, but most bees have never met Philanthus and never will. As well expect human beings in general to have perfected a defence against sudden attacks from man-eating tigers.

"And if you can solve this," Fabre goes on, "then I will put a second problem to you. Why when enclosed together does the bee seem hardly to trouble about her formidable neighbour, and why, on a thistle head, will assassin and future victim drink side by side?"

When enclosed, any bee has only one idea—to get out and return to work. As for the thistlehead, no bee, bumble, solitary, or honey, takes notice of anything except the job on hand which in this instance is the gathering of nectar. It ignores other insects. The bee probably has more enemies than any other creature. If it ought to have learned correct counter measures to the spring of the Philanthus, then it ought to have learned counter measures to the attacks of a hundred additional enemies also. I think Fabre means that it ought to have learned to avoid the Philanthus by flight and not to sip honey when Philanthi are around. But why only Philanthi? Dragon-flies, spiders, hornets, birds and the like are always present, and the only evasive tactics that could be practised with all of them would be to stay at home and never go out.

Then Fabre would say then how silly the bee was to starve to death; that it ought to go out and get honey and take its chances. Fabre is a very difficult man for an insect to please.

One must assume, and the lack of reference goes to prove it, that Fabre did not really perceive the exact method of the stinging of Segestria by Pompilus. These things happen so quickly. Often all the observer sees is a sudden scuffle and then an inert corpse. At any rate he tried his glass jar method again, though even he was beginning to have doubts as to its efficacy. He did it he says, "without expecting results of any particular interest, for in captivity the respective talents of the huntress and the quarry seem to slumber."

He put them in the jar—a *Pompilus apicalis* and a *Segestria perfidia*—and when they refused to have anything to do with each other, being more intent on getting out of the jar, he shook the jar and brought them together. He was standing no nonsense this time. And he kept on shaking them together whenever they parted.

The Pompilus had a wretched time. It was mauled, cuffed, and thrown about by the spider. But one must say this for Pompili—they never show the white feather. This one offered no aggression to the big bullying spideress and never retaliated but, though she must have been sore all over, she refused to show fear. She stood in front of the spider and with affected nonchalance combed her antennae until another of those what Fabre calls "judicious" shakes brought her another buffeting.

One thing is certain; she was quite helpless and utterly at the spider's mercy. Why then did the spider fail to use her fangs in which case Pompilus would have been dead in the twinkling of an eye. I am one of those who can usually think up some explanation however absurd but in this instance, I confess, I can think of none. What is more to the point, neither can Fabre. Can it be—but no, I will say nothing. The facts are there and you can think out your own theories. For some reason—and the Black-Bellied Tarantula did the same—the spider was pulling her punches.

Nevertheless she was putting this jaunty little wasp through the mill in no uncertain way and giving her every reason to comb herself. "The attacks of the Segestria," says the callous Fabre, "stimulated by my shakes, are repeated ten times over." Possibly it was a prolonged exhibition of sadism in which female spiders seem to indulge. Perhaps she did not want to kill her victim yet. Even Fabre relented towards nightfall and screwed a bit of paper up and threw it in the jar. That, he said, will give the Pompilus a retreat during the night. She can hide there so that the spider cannot get at her. "Though her tranquillity," he goes on to say, "as she keeps on jauntily curling her antennae in face of the Segestria reassures me as to her fate."

By now his plan to see the exact method by which Pompilus kills *Segestria perfidia* must have undergone considerable modification.

Tranquil or not, the next morning he found Pompilus dead in an inadequate fold of the screwed-up bit of paper where she had taken refuge but been sought out by the spider and put to death.

Deadlier still to spiders is the hunting wasp Pelopaeus but you will never find her in Britain. Even the south of France is barely hot enough for her. Her larva likes a temperature of 100 or more (130 is not too much) so that even in the fierce heat of the southern part of that country she makes her nests inside boiler houses, near furnaces, or in peasant chimneys where a fire for cooking or washing clothes is always alight. She is happier, and more plentiful, in the hotter parts of Africa, and there I have watched her and envied her contented activity in a temperature that was nearly killing me.

She is elegant, long waisted, and one of the handsomest of the huntresses. But her elegance does not prevent her having a most wicked sting. Indeed she and Pompilus are, I think, the only hunting wasps capable of hurting the blunt sensibilities of men. I am always sorry for spiders. They have a grim life. But I am especially sorry for those unfortunate enough to live in the hunting grounds of Pelopaeus. They have as peaceful a time as rabbits when ferrets are working.

We have met those who dig in the ground and those who bore into wood and pithy stems. Pelopaeus introduces us to a new type of wasp architecture. She *builds* her house. She does not go so far as to build it of cement—though later on we shall see those who do—she makes it of ordinary mud. She belongs therefore to the class known as the Mason Wasps. Having chosen her site Pelopaeus goes to some muddy pool or trickle of water. It is impossible to give even a guess as to where the site will be. It may be anywhere that for some reason appeals to her feminine fancy; under an eave, between two crumbling stones, in a porch, in your living-room; and in countries *she* considers cool in boiler houses or other heated places. The spot chosen will almost invariably be covered over, because, her nest being of mud pure and simple, rain would wash it away. The interior of a certain Police barrack room in Africa always had several Pelopaeus nests attached to the wooden wall and none of the troopers ever paid any attention to them—nor the wasps to the troopers. At one isolated outstation in Rhodesia I got extremely attached to a handsome blue Pelopaeus who shared my lonely pole and *daaga* hut. I used to think she rather liked me too but I dare say I flattered myself. I must at least have given her many a laugh, for in my ignorance I used to try to help her feed the baby by offering her spiders *I* had killed. She would look at them and then fly quickly outside—probably to relieve her pent-up mirth. Once I pushed a spider in, or nearly in, her mud cell, and found it on my bed that evening. This rather peeved me.

She is the happiest of all the hunting wasps and when she goes to her pool and stands on her head in the mud with her abdomen well raised to keep it from getting dirty, she sings joyfully. There she kneads and rolls up mud or clay into a neat ball and flies off with it to her selected site. Her nest is a cylindrical affair composed of rings of this mud and it takes about two loads to make a ring and about forty loads to make a completed cell.

At this stage the cell is a beautiful symmetrical ringed vase, but now she spoils it and plasters it all over with more mud until it is merely a blob. She has, of course, left one end open (at least we hope so: some absent-minded Pelopaei have been known to close it all up and clean forget to provision it or lay an egg) and she now proceeds to cram spiders into it. "Cram" is the word. She pushes spiders in until the inside is solid with them, and all, or nearly all, alive. She cares not what sort of a spider it is; what breed, what shape, what size, so long as it is a spider. This is not quite correct, perhaps, for some individuals seem to prefer large ones and some small, though the majority take what comes. A cell holds about five large spiders or twenty-five small ones, and the average contents are 8 to 10. When the nest has been provisioned and the egg (we hope) laid, the cell is closed up and another one started. The cells are usually adjoining and may be vertical or horizontal or both. It took my Pelopaeus fully three days to make one cell and provision it, but the Peckhams say they do it usually in one. Perhaps mine lacked the American hustle.

To see a killing we must go to others. My own blue lady friend ought to have provided me with abundant data, but for some reason she respected my hut; at least she never turned it into an *abattoir.* There were spiders inside in plenty, but perhaps she thought they were mine and that I wanted them for myself or for my own baby. Anyway, she never touched them but went afield and got her own. There certainly was a lot of understanding between us and consideration the one for the other: even the return of my gift may have been meant in a kindly way.

It was on a cottage wall that the Peckhams saw hunting going on. A Pelopaeus arrived and immediately began investigating cracks and crevices and bits of web, running along the wall like a springer spaniel along a hedge. A spider was soon flushed and dropped to the ground. Pelopaeus did not go after it, there were plenty more, she knew, in the wall. Then in quick succession, like bolting rabbits, three more dashed out and tumbled to earth. Again the wasp ignored them. The next one was larger and Pelopaeus collared it before it fell. She held it in her jaws and between her front legs and rolled it into a compact ball and stung it. Then she rolled it round again and stung it a second time. Then she carried it off. Another wasp appeared. This one missed two spiders and got the third. It was stung immediately without any rolling and borne away. A third wasp caught the first spider she flushed and carried it off, stinging it on the wing.

Wasp after wasp came along and the chase was fast and furious. What a life for the spiders on the cottage wall!

All this shows how dangerous it is to generalise on insufficient data—especially with hunting wasps. Had the Peckhams seen only one kill—let us say the first—they would have concluded, and numbers of natural history books would subsequently have recorded, that this species of Pelopaeus ignores spiders that fall to the ground and takes only those it catches straight away, that it rolls its prey into a ball before stinging it, and that it always inflicts a second sting before flying off. Or had they witnessed only the third our books might now inform us that this species stings only on the wing. This may be exaggeration, but it *is* assumed, far too often, after a naturalist has seen and described a certain incident, that all the members of that species will necessarily behave in the same way under similar circumstances. It is more the stay-at-home naturalists, the classifying and collecting type (no gibe is intended), that fall into this error. Dead bodies conform so ideally in every way, species by species, that some scientists fail to understand how much the living counterparts may vary the one from the other.

The two species the Peckhams saw hunting were *coeruleus* and *comentarius*, the one blue, the other yellow, and both behaved in the same way—that is to say either might do anything. Some followed the spiders when they dropped to the ground and got them there, though the usual thing was to let them go. Had spiders been in short supply (and on that particular wall it is a wonder they were not) all those that fell would undoubtedly have been followed, but it was much easier for the wasps to keep on one plane and grab only those that were in their path. And in this I think they showed both good sense and experience. Perhaps it was the novices who dashed after the ones that fell.

The stinging was naturally hard to observe. The Peckhams often saw the wasp's abdomen curve under the fat belly of the prey but they could never be certain exactly where the sting was inserted. What we really want is a slow motion picture of these stingings but I know of no film combine that is ever likely to get us one. The Peckhams thought that, taking an average, the usual thing was for Pelopaeus to sting her victim twice, first at the moment of capture and then a distance away on some tree or plant where she could look the captive over at her leisure and determine what further treatment, if any, was called for. And the Peckhams ought to know. They handled over two thousand of the victims of Pelopaeus taken from their cells. Many were dead, many lived for a week and others lived for varying periods up to forty days.

Let us pause for a moment and try to realise what our more conscientious observers have to do to provide a small piece of knowledge. Every one of those *two thousand* bodies had to be arranged and studied every day with a lens for the detection of any signs of life. Even the dead ones could not be classed as dead until signs of decay were apparent. And this for six weeks by two unpaid people. Think of the set-out any government department would make of it.

Pelopaeus possesses none of those irritating changes of mind found in Pompilus and others. Nor does she suffer from misgivings about her nest and keep rushing to it and dropping her spider or hanging it up like washing on the line. She knows her home is well made and she never errs in getting a spider that will not fit. With her we are spared the distressing spectacle of a wasp tugging at prey too heavy to pull or too large to go in the nest. Having looked the thing over on a leaf or somewhere and decided that it is fit in size and condition for storage she simply flies home with it and pushes it in. And when she has filled her pot she seals it and starts another without any delay or procrastination.

On which of the mass of unfortunates does Pelopaeus lay her egg? Fabre says she lays it on the first spider she stores. The Peckhams say she lays it on the last. Both have examined hundreds of cells so both must be right. And yet it is strange that members of the same genus should behave so differently in a matter controlled purely by instinct. Evidently even the wasps on the other side are drawing away from us. Pelopaeus may make as many as twenty cells in a season. The first cells produce wasps that year that also mate and breed; the cocoons of the later ones do not emerge till the following June. No wonder they are a flourishing race; no wonder the Peckhams say, "Poor spiders! It is strange that there are any left, such thousands and tens of thousands are destroyed by these tremendously energetic enemies."

Fabre has a lot to say about Pelopaeus and he made an experiment in order to show—as he loves to do—what fools the hunting wasps are apart from instinct. A Pelopaeus had a cell in a dark, smoky, steamy fireplace and when she had inserted her first spider and laid her egg on it, he took the spider away with his famous pair of forceps. And now what, said he, rubbing his hands and grinning, will Pelopaeus do?

"Will she act sensibly and repair the loss by laying a second egg?"

Back came Pelopaeus with a spider, pushed it in, and flew away.

"Not at all," said Fabre when he saw it. "She behaves most absurdly."

They always behave "absurdly" in these cases according to him. But as I have said before, he invariably expects them to behave with more intelligence than he would himself. If they do not they are "absurd." Why in a completely dark cell and doing a rush job should Pelopaeus be expected to discover the absence of a spider, still less of a tiny egg? She knew she had put a spider in and she knew she had laid an egg on it. Why should she interrupt her work by going inside and searching? It was simply a case now of putting in spiders as fast as she could get them. Wasps are busy creatures.

Well, Fabre kept on removing spiders and Pelopaeus kept on bringing them. It was a case of the widow's cruse reversed. For two days Pelopaeus continued to put spiders into this "insatiable jar" and after she had brought twenty she gave it up, sealed the jar, and left it for good. Fabre has made this experiment in different forms on different wasps before and it has been recorded in these pages and commented on. He does not say—he rarely does—what the wasp *ought* to have done. Ought she to have continued to bring spiders so long as he removed them? Or what? No, I think Fabre set this wasp a problem with which he himself, for all his knowledge, would have been quite unable to cope if the experiment had been tried on him.

Yet even Fabre at times was a little worried. His *idée fixe* had led him to take a stand from which he could not budge, but such an observer could not fail to have had misgivings at many of the things he saw. So he admits that "pure instinct if it stood alone would leave an insect powerless in the face of circumstances." The insect needs, he says, a guide in the unexpected. Intelligence he dismisses at once, but he grants discernment. There seems no difference to me between the two, but perhaps I am wrong.

In my comments so far on these experiments it might seem that I myself am hide-bound and adhere as rigidly to the theory, that the hunting wasps *have* intelligence as Fabre adheres to the theory that they have none. This is not so. I have an open mind—with rather a destructive bent perhaps. At any rate I like to scrutinise the inferences drawn from the data supplied and if I find a flaw I point it out. It does not follow that I think intelligence rules every action of the wasp as it makes and provisions its nest. Obviously this few weeks old creature straight from a life of pleasure is largely ruled by instinct. But maternal instinct, it seems to me, like some gland roused to activity in the body, has the effect of transforming the subject, of giving it not only purely automatic impulses but of awakening an intelligence that otherwise would never have been jarred into activity. The two go together; a blind impulse and a keener mind.

Consider any animal or bird—and include even the domestic hen if you like; when motherhood comes it gets, in addition to bravery and the instinct to care for its young, an increased intelligence. The fox is not lacking in brains at any time but when with young it surpasses itself in cunning as it raids poultry houses it would never have dared to approach before. And is the simulation of a broken wing by the mother partridge merely instinct? I doubt it.

This is not to say that this added intelligence takes control and that instinct is a minor partner. The two are often in opposition. So although many of Fabre's experiments with hunting wasps have not always proved, to my mind at any rate, what he wished, some have.

Here is one—at the expense of our friend Pelopaeus. Fabre's comment on it is that her behaviour was "so absurd that one would never have dared to foresee it." And for once I agree.

The experiment was simple. You know how Pelopaeus, having made her shapely cell, plasters the thing over with rough daubings of mud. Fabre found a Pelopaeus just on the point of adding this outer casing. He removed the cell, which was attached to a mortar wall, leaving only the circular mud base. The wasp encased this base with her normal covering just as if the cell were still there. The time had come for doing the outer plastering and the outer plastering she was going to do —cell or no cell. Yes, this *was* absurdity, and I can find no excuse. But I wish he had done it with other Pelopaei. The actions of one are not final. And Pelopæus often *is* so absent-minded.

Agenia, the fourth member of the Pompilidae family we mentioned some time back, is also a worker in mud. She builds a number of small cells and puts one spider in each. Before doing so she generally removes the legs; a sensible thing to do because a spider's legs take up a lot of space and are not edible. She also is very absent-minded and besides sometimes forgetting to take the legs off, frequently loses her own house in spite of the fact that she is constantly going to and fro. Returning with her load she often goes in the wrong direction and searches in places nowhere near her home at all. Only by going back to the starting point and paying more attention to what she is doing does she find it, and all this, happening so often, entails a great waste of time for so busy an insect.

The fifth member, Ceropalis, though similar in appearance to the others and possessing a sting, has fallen into evil ways. She has become a parasite and lives on her sisters, bringing up her young on their spiders.

The Peckhams did not only study the victims of Pelopaeus. They kept quite a large hospital for stung spiders with records of each patient. Amongst these records we find reference to three casualties admitted after being stung by *Aporus fasciatus*.

This is a grey, rather drab female about half an inch in length and possessing no waist or any pretensions to good looks. Like Pompilus she is an earth digger and appears to be a most casual and unreliable operator with the lancet. Of these three victims (dug out of three different *fasciatus* nests) the first was "moving" and improved rapidly from day to day. Just when it was getting on so nicely the records, for some unknown reason, terminate and we are left in the dark as to whether it recovered or had a relapse. The abrupt cessation of further reports, however, is ominous and one fears the worst. The second died on the sixteenth day after admittance. It was totally blind, as if the sting had touched the optic nerve, so that death was probably a merciful release—especially since it was a wolf spider depending on its eyes for its living. The third—and this is interesting—*completely recovered* by the seventeenth day and was released from hospital. I should imagine this subject was the only one not to leave that place feet first.

So far we have barely seen the male of the hunting wasps. The reason is that we have not bothered much about flowers. We have been too busy, it seems to me, in the slaughter-house. Yet even the male, aesthetic though he is, owes his life to slaughter and at one time managed to put away what would amount with us to the carcass of an ox a day. His superior attitude therefore is not really justified and his lack of co-operation with his wife calls for censure. True, he is unarmed and is small and weak but one would have thought that he could have given her *some* assistance with her more obstreperous victims. This he never attempts to do, and when his wife goes off on her killing expeditions he stays, like Ferdinand the Bull or a character from "Patience," sniffing flowers.

Before this of course, they have played about together and she has become pregnant. And in her leisure hours she goes back to him. Quite an enjoyable existence for the male; nectar to sip, flowers to bask on, and a lady to visit him. At night he returns to the ancestral home, if there is one, or finds room at some hostel, some sheltered niche, with others of his kind. He *may* dig out a small room for himself but it is unlikely that he will put himself to the trouble. He leads in fact a life of pure pleasure and the female acquiesces in this idleness—an unusual thing for a wife to do; one would expect her to indulge in a certain amount of nagging even if with her superior weight she did not adopt sterner measures.

But there is one exception—at least one known exception—and that is the lady we are about to study. She alone of the hunting wasps has been able to get her husband into harness and make him work. He does not help her in the slaughter, nor in the hauling of the carcass; he stays at home and keeps house. We have here a complete reversal of the usual order: the male staying at home while the female goes off hunting, proud to think that her little spouse will be waiting to welcome and congratulate her when she returns carrying her game.

Her name is Trypoxylon, and she must have come out about the same time as Ammophila for she effects, with considerable elegance, the same slender waist. Wasp ladies so shaped are usually exquisite operators and Trypoxylon is no exception, and the much-harassed spider is the subject she selects. Definitely this arachnid gains an unsought first place in popularity with wasp mothers.

As her name implies, she is a wood-borer, though she prefers to be given a start in the shape of some hole; a nail or beetle hole, or some crevice. Also, like the Crabros, she uses the stems of plants.

On the departure of the female the male takes up his position at the entrance and rarely budges from it, except perhaps for a short turn or so outside for exercise. It is a pity that the other huntresses have not got their husbands into shape like this for he fulfils a very useful office; he keeps away the parasites. All the hunting wasp wives could do with a good reliable guard and it would save them a lot of work in closing up their nests when they go out. The majority of these Trypoxylon menfolk are quite conscientious, they rarely go off for a quick one at the nearest local honey-bearing flower when the wife's away, and every parasitic fly that comes along is chased off with zest for a considerable distance.

Poking about here and there are several unmated males, licentious bachelors, and these too the husband sends about their business promptly. I regret to say that strange females who enter—as they not infrequently do—are *not* chased away but are allowed inside, and even followed in. I do not wish to slander him ; perhaps he feels they are too big and strong for him to tackle much as he would like to. Anyway they are very soon chased off when the wife comes home. And the wife herself is not above suspicion. Should her husband be away (for he *is* allowed out at times) and a strange male arrive no virtuous indignation is shown and the bachelor is allowed to enter, to be turned out in his turn when the husband comes back.

When the female comes home the male flies out to give her entrance room and as she goes in he alights on her back and rides in with her. He returns with her from the interior in the same position but the moment she is out he dismounts and flies back to his post, backing in so that his head is at the entrance as usual. It is not known whether intercourse takes place on these occasions, but many male insects, locusts for example, like to sit on a female's back for no apparent reason.

The home being completed and a foundation of mud laid at the bottom, Trypoxylon goes forth to get her spider. She selects her prey as a rule from amongst the web weavers. She is an artist and likes to perform her work scientifically and it is not a fight she wants but a careful operation. She therefore prefers spiders she can master and hold down. Also the opening to her nest is generally a small one so that the spiders must be small too and, like Pelopaeus, she does not make the silly mistake of many and kill spiders too big to go in.

The nerve ganglia of spiders are situated more or less together, so Trypoxylon has not a difficult job. The Peckhams only saw one kill and that by chance. The wasp caught the spider on a leaf and held it down firmly while her abdomen curled underneath and inserted its dagger with precision into a spot in the soft unprotected belly.

The paralysed spider is now taken home and rammed in. "Rammed" is the only word, for the spiders of Trypoxylon are jammed into a solid mass. The female pushes it in and butts it into place with her head, "totally" as the Peckhams quaintly say, "disregarding its comfort." A particularly domesticated male may help in the packing but he is the exception and is, no doubt, held up as a pattern by all the other wives.

CHAPTER 8

THE ANT HUNTERS

AFTER THE parasites, ants are the chief scourge of the hunting wasps. We ourselves know their aptitude for discovering any scrap of food left unprotected and the miraculous way in which this food will be covered by a swarming mass in hardly any time at all. Many a sandwich have I left on the ground after finding it covered with ants. One *can* brush the ants off of course but an odd ant or so is small and easily overlooked, and ants are not pleasant things to eat. The hunting wasp is more handicapped than we are; she cannot brush the ants off. Her only chance is to keep them away from the beginning by hanging her meat up as Pompilus does, or hiding it. Ants also get into the stored nursery by digging from various quarters and observers on unearthing a completed cell have often found it swarming with them busy eating both the larva and the provisions.

What steps can the hunting wasp take about this? None at all. She loathes the persistent little red things but she has no weapon that can deal with them. Evasion is her only chance. She is not a fighter, although because she is a slaughterer many expect it of her. This is unfair. We do not expect our own butchers to be prize-fighters. Apart from killing their sheep or oxen they are generally meek and mild men who like a quiet life. The hunting wasp is the same: away from the *abattoir* she does not want to kill anything. She will even run away from her own selected beasts of slaughter unless the carcasses are required for infant consumption. *When* they are required those on the list suffer heavily, especially such favourites as spiders, but ants are not on the list except, so far as I know, in the case of two genera.

The one lives in Europe and is said to take worker ants—those hard, brittle, indigestible, nipping things that nearly all insects and most of the birds avoid. The other is American, *Aphilanthops*, and its species *frigidus*, and it displays to my mind a great deal more regard for the stomach of its child than Fertonius, its European ant-killing relative, for it eschews the worker ants and takes only the queens. These are soft and plump and even human races look upon them as choice food.

At certain times in Africa the ant-hills erupt like volcanoes. And at this eruption the natives run, not away from but to the volcano. For issuing therefrom are tens of thousands of their favourite article of diet—the flying ants. They pick them up between thumb and forefinger as they emerge and pop them into their mouths. The motion will go on as continuous and rapid as that of a boy bolting strawberries in the pantry.

Succulent as are flying ants to natives, they can hardly be able to appreciate their full flavour for they are swallowed so rapidly that the majority must reach their destination alive. In fact at the end of the session the stomach of each native must be packed to bursting point with a heaving mass of lively ants that have never yet flown and certainly never will. The natives always depart with a look in their eyes that combines intense satisfaction with slight alarm.

I am, I know, out of order. These eruptions were the produce of white ants, which our scientists keep telling us are not ants at all, and they were composed not only of queens but of males too. But the idea is the same and the flying males are just as popular as queens with those that have acquired the flying ant taste. I am not amongst them. I have always been conservative. For instance I would never eat the maggots from bees nests taken in the veld, though my colleagues used to tell me these were much the better part, and a prospector, a Scot, once told me that flying ants were delicious. He said he used to go out and get a supply whenever an ant-hill was in an active state, and cook them in a frying pan. No fat, he said, was required since they had plenty of their own. The wings, he admitted, were a drawback since it was impossible to remove them all, but they were probably good roughage."

So it can be understood that queen ants may well prove nutritious for growing wasp children. A problem presents itself. But first let us glance over the general arrangement. These Aphilanthops select (as so many wasps do) a sandy dune-like place, though one not devoid of short vegetation. They work more or less in colonies, and the entrance to their nests, which may be 18 inches underground, is cup-shaped. They seize their queen-ant and paralyse her, then, clasping her between their legs, fly home with her. They drop her into the cup-shaped entrance, go down the hole, turn round somewhere inside, come back face foremost, and drag her in. But a mishap often occurs owing to the heavy weight of the queen-ant and she is not infrequently dropped en route in mid air, just as a careless housewife may drop a heavily laden dish when trying to rush with it to the larder. The result, unfortunately, is usually a total loss to the owner, for base thieving members, hardly worthy of the name Aphilanthops, are always on the lookout for such a gift and lose no time in "winning" it.

For further details we must go to the Peckhams, who studied aphilanthops with their usual thoroughness. That this wasp has its share of common sense as well as instinct is quite obvious, and three things that the Peckhams noted serve to my mind to show it. The first was a wasp that could not find her house. She alighted near two small tufts of grass and dug confidently, realising at last that there was nothing there. She staggered about with her ant, digging here and there but could not find her home. She studied the terrain and dug near two other tufts, gave it up and dug near two more. In ten minutes she was very worried indeed and dropped her ant (though she hated to do it and kept running back to look at it) and dug in earnest all around—always keeping her queen under observation and taking it with her when the digging got farther afield. In an hour she was forced to face the fact: her home was lost. So she dug a new home and took the queen down. The hole was only half-completed when she got her ant to safety within, as was shown by the jets of sand that were thrown out for some time afterwards. It was obvious, the observers said, that she had mistaken two tufts of grass for two others like them.

And where, you may ask, does the intelligence come in? It comes in in the way she sought for the lost nest and kept her ant with her, and it comes in in her stopping the search and making an entirely new home. It was intelligence also that advised her to get her ant inside as quickly as possible, even although the nest was not finished, before parasites or robbers got at it.

The next example is due to the Peckhams' desire to examine the cache of this wasp. This they never managed to do. You see they could not trace the tunnel in that shifting sand—everything just fell in. So they got an idea, and when a wasp dropped an ant in the vestibule and went inside in order to turn round, they tied a piece of cotton to the ant, and when the wasp came up and took the ant down, the cotton travelled after it. Everything went according to plan for a time, and then the cotton stopped being drawn in. After an interval a slight pull brought the cotton up with nothing attached; the wasp had discovered it and bitten it off. A second similar experiment on another wasp produced the same result. I do not think I need comment on this at all. Instinct certainly never taught a wasp how to deal with a piece of cotton tied on by human beings. The cotton did not even stop the ant being drawn down. It was something entirely new to the wasp. Yet even you or I could not have dealt with it more sensibly.

The observers next noted a wasp carrying its ant that kept approaching and almost alighting at its nest, and then rising and circling round and almost alighting again. The manœuvre was repeated so often as to attract their undivided attention, and at last they saw the reason. Two flies—parasites of course—were following this wasp, keeping close behind but at a definite fixed distance, as is their habit. In the end the wasp made a sudden swoop at her hole and disappeared, taking her ant in with her, although normally, as we know, she makes a considerable set-out about getting it down. There was nothing very spectacular about this perhaps but all the same it showed sheer common sense entirely unassisted by instinct.

The fourth example was not a field note but a deliberate experiment of the Peckhams. It was an experiment we have met before—in fact everyone in a position to do so seems to try this childish trick. It consists of removing the prey a few inches while the wasp is down the hole. It is a trick on a par with that of small boys who ring a front-door bell and run away. They too are experimentalists and acute observers and from some corner note the various reactions of the householders. The Peckhams did it with an ant a wasp had left on the porch while she turned round inside; they removed the ant an inch or so. Five times the wasp brought it back and went down and took its usual time in reversing, but the sixth time, as it was going in, it suddenly wheeled round and foiled the jokers. As I say, the small boy experimenters are on the same track as the Peckhams, but with more advanced subjects. It would be interesting to read their notes and to find out how long it takes *Homo sapiens* to tumble to the trick—assuming they keep on ringing one particular bell. Perhaps a reader will put in some research in this direction and let us know the results.

I mentioned a certain problem about these queen-ant hunters a few pages back. This is it: the Peckhams saw the wasps bringing in *winged* queens only. On no occasion were any queens without wings brought along. Now the ant queens on their nuptial flight issue winged and immediately they come to the ground they cast these wings. I am sure I must have missed something here for I cannot quite see the Peckhams' difficulty. Why should not the wasps act like the natives and grab the queens as they come out—or catch them when they are in the air. They *did* see a wasp carefully studying the opening of an ants' nest, lying in wait as it were. But nothing happened and they wondered if it were trying to pluck up its courage to go inside. That it might have been waiting for a possible issue of queens seemingly never occurred to them. That is why I feel I must have overlooked something, for the Peckhams are not likely to make mistakes. They argued that because the queens brought in had wings therefore the wasps did not pick them up running along the ground. That was obvious. But they went on to assume that the wasps must therefore enter the nests. This seems to ignore the movements of the queens in between.

To find out whether they were right or not they captured a wasp in a glass bottle and inverted this bottle over an ants' nest. The wasp mooned about a bit and then, showing far more faith in the Peckhams than I would have done, walked calmly down the hole as if she belonged there. There was an interval of peace, and then she shot out pursued by a whole army of furious ants.

"Down," say the Peckhams, "tumbled our air castles, for however *frigidus* gets her queens it is not in that way." And at that they left it, hoping that some day they would solve the problem. I still shake my head. I still ask *why* should not *frigidus* take her ants in the air or as they emerge?

CHAPTER 9

THE CEMENT MAKERS

I SUPPOSE the two genera we are about to inspect ought to have gone into the first chapter, for both are caterpillar hunters. But scientists dislike them to be lumped with the other solitary wasps because these two can fold their wings lengthways like the social wasps and the others cannot. Their names are Odynerus and Eumenes and they have a much more important claim on our notice than the way they arrange their wings when not using them. They have thought out a new and entirely original device. The problem before the hunting wasps has always been the extreme fragility of their egg and of the ensuing baby, combined with the fact that the baby cannot eat putrefying meat. Take the egg: two mishaps may happen to it. It may fall to the floor from the carcass to which it was glued, or some imperfectly paralysed prey may give it a knock. Either of these mishaps is fatal, and the same applies to the larva in its younger stages. We have seen how the others dealt with this problem and have admired their ingenious paralysing method. But we have also noticed snags. The most careful and precise surgery is necessary, and one is not surprised to hear—from the Peckhams and others—that the knife sometimes blunders. They have the requisite technique but with their struggling and kicking subjects they *some*times make a mistake.

For a long time it was thought that Odynerus (and Eumenes) laid her eggs just as the others—on one of the caterpillars. She was studied with great thoroughness, particularly by Rèaumur and Jean Dufour. There seemed nothing more to be learnt. Every detail about her marvellous architecture was known at its every stage, and the breed, size, number, and habits of the stored prey examined minutely scores and hundreds of times. It was Fabre who came to the conclusion that there was something very peculiar about this wasp—something he did not understand. It was his custom, whenever he could, to bring up the larvae of the various hunting wasps himself by transferring them, with the stored provisions, to special receptacles in sand or some other medium that he had prepared. He became so expert that provided he used care in the removal (which he always did) the result was a foregone conclusion: the larva ate the food (which the mother had brought for it originally), spun its cocoon, and came out the next summer. So when he tried the same thing with the larva of a Eumenes he thought little of it. His method he knew by now was foolproof.

But the Eumenes grub would not touch the provisions, indeed it seemed scared of them, and died of starvation. Other attempts gave the same result.

By now you know Fabre. He was going to get to the bottom of this. He pondered over every possible cause of the failure and remedied each one. It was useless. Whatever he did the grub went on hunger strike and died.

Lesser men would have given up, but Fabre decided to see what went on under natural conditions ; not an easy thing with a sealed cement jar. For Eumenes brings up her young in a clay vase, and Fabre had always, with the most delicate care, broken the vase to get at the contents. And the breaking up had naturally commenced at the top which offered least resistance. His job now was much more difficult. He made a tiny window in the side of the vase through which he could study what went on. And at last he saw, through his window, a silken thread, invisible except with a magnifying glass, suspended from the top, and hanging from it the minute egg. The egg hung over but did not touch the piled caterpillars below.

It had been noted before by every observer who had studied them that the caterpillars stored by both Odynerus and Eumenes were in a state of extreme liveliness (that fascinating word). In fact Rèaumur stated that they were all put in alive and unharmed. We know now that they are stung, but only slightly and in one segment. This is because, with their new invention, there is no need for Odynerus and Eumenes to make their prey rigid.

But let us see exactly what happens: let us study this scheme as demonstrated by Odynerus. She makes in cement a horizontal cell, broad at one end and narrow at the other. From the ceiling of the broad end she hangs a silken thread and on the end of this thread, in mid-air, she suspends her egg. Under the egg she places two or three caterpillars, and in the narrow part of the cell she places a lot more—about 20, jammed together so that they cannot move or wriggle away. What happens? The egg splits and a tiny yellow larva emerges. It does not fall to the ground but hangs from the end of the shell of the egg, thereby lengthening the thread. The larva stretches its little head down and takes a small bite out of one of the recumbent forms below.

Now, as I have said, these caterpillars have not been treated severely and are not inert. They are indeed far from being so and observers have found that, at a touch, up will go their tails. They have in fact only been treated in the head end. So on the bite being taken the caterpillar rears and the scared larva streaks up its thread out of harm's way. By and by, when all is quiet again, it steals down and takes another bite and the caterpillar rears as before. As the caterpillar weakens with this treatment the grub grows stronger. In 24 hours it has eaten the caterpillar, and starts on the next. With the body of a whole caterpillar inside it it is, of course, larger and stronger and by the time it has come to the third it discards its life-line and is able to cope with any struggles that future victims may make. After that it eats the remaining 20 in the narrower part of the room and spins its cocoon. And this device seems to have been patented by Odynerus and Eumenes for none of the other wasps use it.

The nests and sites of Odynerus vary. Some choose a little niche or hole, in a window-frame for instance, or a wall. One selected an old horn hanging up in a porch. But *spinipes* and *reniformis* (and some others), the most expert masons of all, adopt a definite plan which they have found good, if complicated.

We will watch *spinipes*, a black and yellow wasp as are all the Odyneri. She selects a spot, a smooth spot on some hard clay bank baked to the consistency of earthenware by the sun. It is clay that would resist the spade of a gardener and leave no mark on pressure by the thumb-nail. An impossible medium, one would say. But Odynerus has her methods, though the task she has set herself is in truth going to be heart-breaking. She brings in her mouth a drop of water from the nearest source which she mixes with saliva and puts on the clay and kneads in. She is thus able to detach a moist pellet of what is now cement. This pellet is not flung away at some distance in the usual wasp fashion but pasted on to the side of the bank, and as she brings more water and excavates more pellets, these pellets are placed next to the first and we soon see that they are being arranged in the form of a circle. This circle defines the future aperture of her nest.

And so, as the work proceeds, we have an opening appearing inside and a little projecting tube outside—for once the circle is made further pellets are placed on top of the others. It is not a solid tube: the pellets are placed in such a way that they can be the more easily removed later, and there are spaces in between them. Gradually, as the shaft sinks deeper, the clay may become moist and the mason may be able to work without frequent trips for water. When the tube outside has grown to a certain length the builder begins to give it a downward curve, so that by the time she has finished it looks like a washing tap. This tube fulfills three purposes. First, the pellets are her bricks and she is going to need them later; so they are all ready for her at her door-step. Second, it saves her the trouble of taking excavated material away and dropping it at a distance as the other wasps must do to prevent their nest being made conspicuous; and third, it wards off parasites by its very presence—which normally attracts them. For parasites hate a tunnel, and one approached by a curved tube quite intimidates them.

By now the shaft has reached a fair depth, but it is not completed; there are many loads still to come up, and these are emptied out from the opening in the curved tube. At a certain distance Odynerus begins to make cells on either side of the main shaft. There are six or seven of them, shaped as we have shown and all in due course provided with hanging egg and caterpillars and then sealed off. Finally, the bricks are removed from the pipe, re-kneaded with water and saliva and used to block up the outer entrance, cementing it in so that it is flush with the ground. If it is cemented in, you may ask, how do the young get out? I have no idea. But they do get out. They have nine months or so to wait, and no doubt the rains and frost and thaws of winter have something to do with it.

Another species, *Odynerus parietum*, makes similar cells, but not in the earth, and she has no tower. She builds them in crevices. Latter tells us how he found one after she had completed the first of a series of cells and was just beginning work on the second. They were being made between the framework and the ledge of his study window. He made another of those so-called experiments when, in the face of disaster and tragedy, insects are expected to behave with cool judgment and calculated sagacity. For he appears to share Fabre's contemptuous outlook on the intelligence of insects.

The experiment he made was not quite so bad as one of Fabre's when he uncovered a Sphex's nest and exposed the larva and left it to grill and writhe in the sun and then blamed the mother when she came back because she rushed about absurdly and did not even know her own roasting baby, but Latter's treatment of the mother's carefully prepared home was abrupt, to say the least. While she was away he broke open the nursery, which she had completed and sealed up, and scattered the contents—caterpillars and egg—around. Then he waited for the wretched creature to come back. She did, and she "manifested," he said, "great consternation at the havoc."

Well, that was something. The same observer has said elsewhere that the hunting wasps after sealing up a nursery have no longer the faintest interest in it.

What did the wasp do? Recovering at last from her consternation she repaired the cell and carefully put every one of those caterpillars back. Then she sealed it again. You see the omission, of course. Latter saw it at once, and great was his scorn—*she never put the egg back* !

Now Latter himself admits that she had never seen any of her own eggs, and also that to place it in the cell with her jaws and feet would have been "something outside her previous experience." I should say so too! And yet he says, "The failure revealed the utter absence of reason in these novel circumstances." Fabre all over again, except that Fabre would have called it absurd.

"Novel circumstance" would be hardly the words a human mother would use if she returned to find her home in that condition—especially if she had built it all herself, brick by brick. The idiot, you will say from your armchair, ought of course to have laid another egg and hung it up from the ceiling of her repaired home. But all she saw (and she was busy attending to her second baby, don't forget) was her wrecked home and her first baby's precious provisions lying scattered outside, and in mending her first home and putting back the provisions—in spite of her state of distraction—I think she did remarkably well. I give her full marks instead of the black administered by Latter. Far be it from me to decry the human race but I know human mothers who in similar circumstances would, I am quite sure, have done nothing else about the matter than go into hysterics.

Sometimes I feel I should like to play similar tricks on certain naturalists: smash their home up for instance and take their baby away and scatter all their furniture and walls and ceilings and milk and provisions around and study their reactions in these "novel circumstances" when they came back and write about their utter absence of reason and their absurdity. But one can't do this: and, besides, naturalists are too rare and too valuable.

No experiments on insects impress me at all, or to my mind *prove* anything at all, if that insect is not in a normal frame of mind.

The species of Odynerus that nest in the stems of plants remove the pith for a certain distance and then make three or four cells that are divided by clay. Odynerus has been praised for only making a few cells and then going elsewhere, thus saving itself the trouble of having to bring up pith long distances. It may be this is right. But surely the fag of finding a suitable stem somewhere else and beginning all over again cancels out the labour, if any, saved. The cells in the stems are, of course, provisioned with small caterpillars tightly packed to about half-way up, and the egg is suspended as a rule from the side of the cell. The caterpillars are so jammed that they have no option but to remain quiet. Sardines in their tin are free and unpampered compared with these caterpillars. This jammed mass—like something in aspic—appears to be a sort of brawn until some naturalist comes along and disintegrates the contents. The contents then wriggle and move most surprisingly. The same naturalist, should he be a tidy man and wish to put them all back, will find he cannot do so; that, in fact, he has a lot to learn about packing caterpillars.

The Peckhams cut out a stalk containing a nest of *Odynerus confirmis* and managed somehow to spill out all the caterpillars but one. Naturally when the egg hatched the grub could not reach its food, but for 24 hours it grew and developed without sustenance of any sort. (Chickens do the same thing.) They then piled caterpillars up within reach of it. The extra caterpillars were taken from the nest of another Odynerus at the same stage of development whose nest they had also cut out and which they were also studying. The first Odynerus ate and thrived on the caterpillars taken from the second Odynerus's nest. But the Peckhams could not keep on robbing Peter to pay Paul, so when Paul had come to the end of all the caterpillars that Peter could spare they did the obvious thing: they got caterpillars from their own garden and also, to vary the menu, some soft and tender little spiders.

One knows what rigid conservatives the hunting wasp *mothers* are but this is probably due to the fact that they are better able, through generations of custom, to overcome and paralyse a particular sort of prey. It does not follow that the offspring has any special bias, indeed we have already seen that some have not. Again the dangers of generalising, for some have. At least Paul had, for not only did he refuse to touch their spiders, but he would not look at their caterpillars. I suppose they were the wrong variety. Anyway Paul would not eat them and died. Personally I felt a bit worried about Peter. A considerable part of his inheritance had been squandered on Paul. Did Peter eke out his minority on what was left? We are not told.

In one Odynerus nest examined the caterpillars had been dealt with by the mother in such a slipshod manner that they kept wriggling out of the way of the larva as soon as the larva tried to take a bite. The Peckhams put a stop to this by wedging these extremely lively caterpillars in place by wads of cotton wool.

Eumenes. Perhaps of all the wasps mentioned she deserves first place and most attention. A lovely creature with a perfect figure and a slim waist and shining in bright colours; broad yellow bands on black. An expert craftswoman too, making vases of earthenware that the Greeks might have envied. But Odynerus in these pages has come on first and got the limelight. Eumenes works on her lines. We have only one species in Britain. She builds her perfect vase amongst the heather and the vase often glitters with bits of quartz or shell. Like Odynerus she has a silent stately flight, and like her puts her baby in a hanging cradle. And so, summarily, we will dismiss her, with apologies.

CHAPTER 10

THE HOUSE OF VESPA

We now come to the highest order of the wasps—the noble army of Vespa, in other words the common wasp that arrives at the time of the ripening of the first plums and stays with us throughout the summer. Yes, this brazen thief, this filcher of our jam and marmalade, this floater in syrup, beer and lemonade, belongs to a very advanced family.

The social wasps originated from one of the hunting wasp families such as we have just been studying; one no doubt that lived in large colonies. It might seem no very startling change, after living in a number of houses close together, to decide to live under one roof, but it entailed (amongst other things) the manufacture of slaves in the shape of sterile females and the development of a mother capable of laying fifty thousand eggs in a season instead of the usual half dozen or so. But in whatever way they got to their present position and from whatever source they came, there they are now, at, roughly, the same stage of development as the bumble-bees and a considerable distance behind the permanent societies of the honey-bees and the ants.

In character the social wasps are loyal, brave, industrious, and extremely ingenious, but they are no friends of ours. Some will disagree; some will say that they destroy large numbers of insects that are harmful to mankind. This they undoubtedly do, but they also destroy large numbers that are useful including the hover flies, those great aphid destroyers. Were their insect-destroying activities the only charge on the sheet the matter would for ever be in doubt, a fertile source of endless argument, but there are other indictments. Ignoring their nuisance "value," which irritates but really hurts no one, they ruin large quantities of fruit (which has already had a hazardous enough career from the flower to the adult ripened stage). We have all seen the pears and plums and other fruit that the wasps have partly eaten; we do not notice those it has merely punctured to get a nice cool drink and which decay later in store, infecting their neighbours at the same time. Nor do most of us realise how much more honey we would get if there were no wasps. In their season they may steal ten pounds of honey or more from each hive, and this direct theft is negligible compared with the fall in output caused by the way they harry the workers.

It was as a bee-keeper that I became particularly bitter against the social wasps. A bee-keeper is not just a middleman between bees and the public. If he is a good bee-keeper he loves his bees as a schoolboy loves his white mice. And how would a schoolboy feel if every time he visited his mice he found them being chivied, tortured, maimed and cut in living halves by rats or weasels? The analogy is possibly far-fetched because a honey-bee is not a white mouse, especially when it is annoyed, but it is not very far out. Laden bees returning with honey *are* practically helpless and quite unable to fight and it is they who suffer and get cut in two for the sake of the rich booty in the abdomen, which is carried off, container and all. Only the guards fight the wasps. These have to be reinforced by workers who would otherwise be bringing in stores. And they are none too happy when the black and yellow Vikings sweep down on them. They are perturbed, not to say distressed, for in tackling wasps they are going right out of their class.

It is all very disturbing to watch and one can do nothing at all about it. So I confess I approach social wasps with a biased mind and if I can find anything to say against them I am going to say it. But I am going to be just. There shall be no libel, nor shall I break the ninth commandment and bear false witness against them. Their virtues will be placed on record just as their sins.

Many distinguished observers greatly admire the social wasps. They call them "pretty" and speak of them with affection. But they mostly saw them during their experiments—visiting bits of honey on variously coloured saucers in their studies—that sort of thing—and behaving in a modest, almost apologetic way. They were not bee-keepers (Lubbock was an exception) and had not seen these "pretty" creatures savagely carving their innocent hard-working friends into living pieces. Even gangsters do at times appear to be ordinary decent folk.

Personally, that is to say in our relations the one to the other, I have nothing against wasps. I would much sooner take liberties with a wasp's nest than with a hive of bees—and if the bees are really gingery there is no comparison at all. Once, in a honey store-room, I *was* attacked suddenly by large numbers of wasps and it was a painful affair. But I had asked for it. I had been busy for some time with a swatter and I admire their restraint in not taking action earlier. Long ago I used to tread gingerly when approaching a wasp's nest in order to destroy it. My heart was not in my mouth but it was not far from it. I no longer take any particular care. I find if I move quietly that they make way for me politely even at the portals of their city when I am introducing the wooden horse in the shape of a spoonful of cyanide. Sometimes I have even felt ashamed at the courtesy accorded and have had to cast my mind back to my harassed and severed friends to steel me to my fell design. For it is a dreadful thing to cut off a city of thousands in the height of its prosperity.

Even so, were all the nests of the social wasps gathered together in one place, and could the family of Vespa, the highest in wasp-land, by the insertion of cyanide be wiped from the earth, I would not hesitate to do it. I should feel no elation. I should feel sad that those with such capabilities had taken paths so much in conflict with our own, but I should wipe them out nevertheless.

And so, with the wasp's comparative lack of aggression towards human beings, the awe it has created amongst some of us is rather surprising. I remember once a girl of about 18 at a tea-party after tennis creating a scene and shrieking because a wasp was in the room. The wasp's only desire was to get out, but she behaved as if her life were in danger. Part of it (all, perhaps) was exhibitionism, but the wasp with many *has* a reputation for aggression that it does not deserve. Even Fabre, whose life was spent amongst insects (so are ours, but I mean in a more intelligent way), and who ought to have known more about them than any one else, was scared of wasps (and of course in this chapter when I say wasps I mean the social ones and not the hunting ones). I will quote his words: "We approach the spot with caution, fearing to attract the attention of the fierce creatures. The inmates come and go, busily passing one another as they fly in opposite directions. *Burr!* A shudder runs through me at the thought of the unpleasant time we should have did we incite these irritable warriors to attack us by inspecting them too closely."

Honestly, this, coming from Fabre, staggered me. Yet I cannot be wrong. For years I have made a practice of seeking out wasps' nests. I have not always poisoned them. I have doped them mildly with ether, chloroform, and dug them up to study them. And all my initial preparations have been done without caution, and when I was at the entrance the wasps, those both going and coming, have obligingly flown round me, heaping coals of fire.

I have been stung, naturally. I am not pretending that wasps are saints or guaranteeing you from puncture if you have dealings with them, but they certainly do not wage the war on us that we wage on them. And what is the sting? For the benefit of those who do not know—if such there be—the two stings, that of the bee and that of the wasp, I will describe them, and if they do not wish to take my word they can easily experiment for themselves. As regards bee stings I can speak as an expert. I yield to no one, for as a beginner I was both a cock-sure and clumsy bee-keeper, a combination certain to bring stings in quantity. Few parts of my anatomy have escaped, for bees can sting through several thicknesses of light clothing. The bee, if it intends to sting, comes at you like a red-hot pellet from a catapult and stings at once. If it alights on the hair it sizzles down till it comes to solid foundation. What happens after the sting goes in depends, I now feel sure, on *where* the sting is inserted. I have had two bees sting me at once (I have also had about a hundred bees sting me at once but this is too many for a proper analysis); the one I have hardly felt, yet the other has given intense pain. I suppose one was near or in a nerve and the other not. Those that hurt *do* hurt; they have a throbbing violence that makes you feel quite wicked.

Compared with this sting of the bee in the right spot the sting of the wasp is negligible. It is just a smart. I received my bee stings long before I received my wasp stings, and when my first wasp stung me I was agreeably surprised. It was, as I have said, just a smart. The snag is that the wasp sting persists. Even after a week one wants to scratch it. So on the whole I would sooner be stung by a bee and endure the deeper pain and get it over. With both bee and wasp the hate and fury shown in those small doubled-up bodies that hurl themselves hissing at you is almost as intimidating as the sting itself.

Now the weapon of the bee and the wasp is defensive. It is a coarse weapon with a channel for the injection of poison, which comes from a sac inside. Any creature which they have decided threatens them or their home they go for. In goes the sting—anywhere at all—and in follows the spurted poison. What of the solitary wasps whose sting is—in a way—offensive? It is a little difficult to find out. Their ammunition, the poison, is precious and they are not going to fritter it away on you and me. You can, of course, by brutal methods *make* them sting you, and when you do you will be surprised. The sting that has such dire and instantaneous effect on a host of creatures from caterpillars to beetles can hardly be felt. A small thorn would be more painful. And when you try to make them sting you I warn you that it is no use holding their abdomen against a finger or any part of the hand; the skin there is too thick for that fine and delicate blade. You must hold it against the wrist where the blood vessels are. And even then you may be disappointed. A lady with a thin delicate skin is the most likely to be successful. Pompilus, the spider killer—as well as Pelopaeus—is an exception. Her sting is not negligible; but those who have been stung by a bee or a social wasp need have no fear of her. She will not hurt half so much.

This sting of the bees and the wasps is a complicated piece of mechanism. A detailed description would take a chapter. We might as well, however, take a cursory look at it without going too much into detail. It started life not as a sting at all but as part of the reproductive organs of the female—her ovipositor. That model however was entirely superseded when nature decided to arm her bees and wasps. The eggs now do not travel inside it at all, issuing instead from the base of the abdomen. If you pick up a worker wasp between the finger and thumb or—and you may prefer the latter method—with a pair of forceps, you will see shooting out repeatedly from the abdomen tip an angry, wicked-looking needle that has the appearance of a fine black hair. And you may possibly see a globule of fluid at the end. "Oh, look!" some say when they see it, "there's its sting!"

But it is not its sting. It is what is called the *director*. For the lancets—and there are two of them—that comprise the real sting are of the most fine and exquisite delicacy and must always be kept in a sheath. Nor must the fineness of their points risk damage against such horny material as your skin or mine. So the *director*, which has itself a point finer than any needle, has a hole at its extremity through which the two lancets shoot when the *director* has pierced the horny outer skin and introduced them into soft vascular tissues. Nature, when she converted the ovipositor into a weapon, certainly took a lot of pains about it. She is never in a hurry to scrap her old models and make new, but when she does she makes a thorough job.

So the first thing that happens when a wasp stings you is that the *director* pierces your skin and goes down into the soft tissue underneath—close to a nerve if your luck happens to be out. Then, driven by levers that are motivated by strong muscles, the two needles shoot out further into the wound. These needles are three-sided, like the needles saddlers use, and the outer V-shaped edge of each slides in a slot situated on the inner wall of the *director*. The sides of the two needles which face each other in the centre are concave, hollowed out so to speak, and together form a pipe through which the poison from the poison sac is forced at pressure. The extremities of the needles are also barbed with six flat barbs and at the base of each barb a channel is cut through into the central pipe. The poison therefore squirts not only from the end of the pipe but through the sides at the base of the barbs.

One would think that at this stage Nature would have considered the discomfiture of the wasp's annoyer sufficient. But no. So far the *director* has shot in a slightly downward direction and the needles, discharging their venom, have issued from their sheath. Now the muscles and lever exerting still further pressure cause an upward movement which stretches open the wound and makes a path for still further penetration by the needles.

As to the poison itself, no one can tell us what that is. It is a trade secret of the bees and wasps. There have been several guesses. Some have said it is formic acid (which it certainly is not), some that it is a strong alkaline (a vague description) and some that it is a mixture of the two. Whatever it is it is potent, especially by the bee.

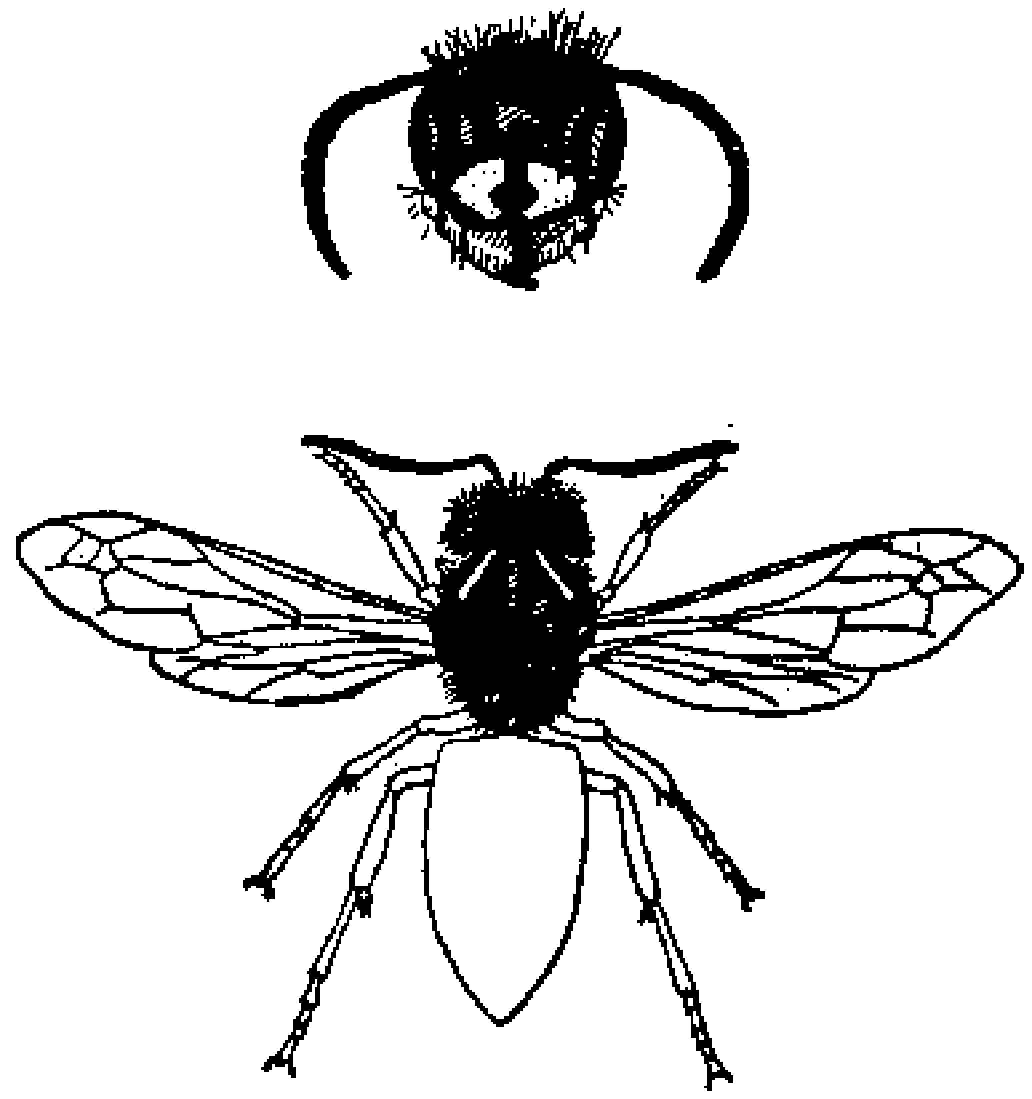
Fine and delicate as is the sting of the social wasp, it is, as I have said, but a coarse affair beside the weapon of the hunting wasp. The first is used for savage, though generally defensive warfare, the second is a surgical instrument. So the needles of the stings of the hunting wasps have no barbs, but are smooth and can flash quickly in and out, as they have often need to do.

We will now examine the social wasps in a more methodical manner. Vespa is the genus, and there are seven species in Britain. The two we are most likely to see, whether we wish it or not, are the German Wasp and the Common Wasp. There is nothing to choose between them. Both have the same habits and are equally numerous. Any wasp you pick up, if you do pick up wasps, is just as likely to be a German Wasp as a Common Wasp or vice versa. You can tell the difference by looking them full in the face, and you will find that this is a dreadful habit that grows on you. Every wasp you see you feel you want to look at and find out if it is German or Common. Looking them in the face, then, at the place where the nose would be in a human being, we find in the Common Wasp a thick black anchor painted on, and in the German Wasp three black dots in the shape of a triangle, like a pawnshop sign upside down.

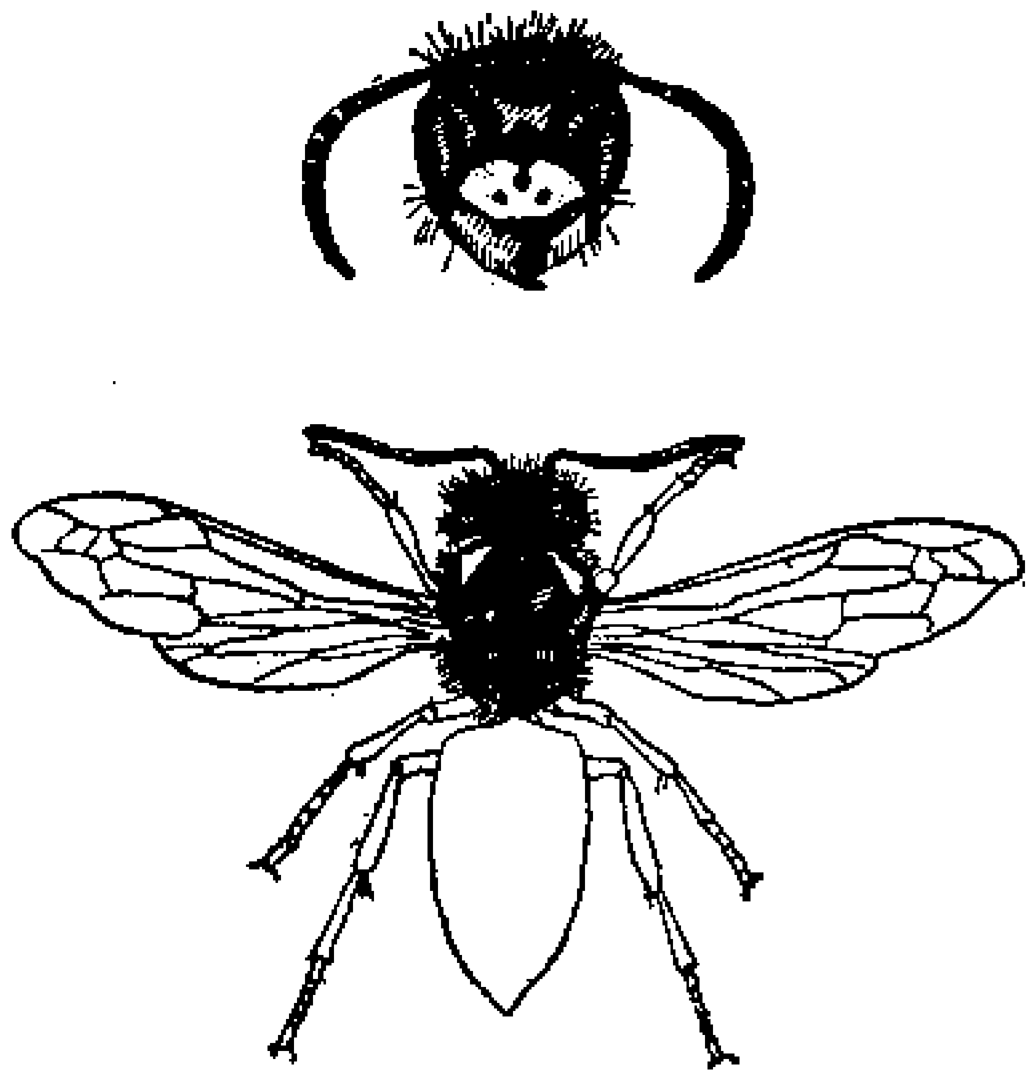
Or looking at them from above, on the thorax, you will see the two yellow stripes that run from the neck to the middle sides where the wings emerge, parallel-sided in the Common Wasp but thicker near the wings in the German Wasp, forming a triangle. There are other slight differences but these will be sufficient. The queens are the easiest to identify, worker wasps sometimes show variations.

The Red Wasp, *Vespa rufa*, is not red at all, but the yellow abdomen and legs sometimes have a rufous tinge. It is common enough but a point in its favour is that it does not come into houses. Nor, so far as I know, does it plague picnickers. In fact, most of the crimes of the social wasps can be laid at the door of those two sinners, Vulgaris and Germanica. It is even doubtful if the other socials do much damage to our fruit. So we need not frown quite so much when we are studying them.

The wasp with the very pretty name comes next. It is rarely that our scientists pander to us in this way. "Vespa" itself is euphonious and why it should have been chosen for these brigands I cannot think, but *Vespa sylvestris* is really beautiful, like the sighing of wind in a forest, and its usual translation, the Tree Wasp, I refuse to use. In spite of its name this species does not always make its nest in a tree. Like the first two it often nests in a bank.



Common Wasp



German Wasp

The Norwegian Wasp is fairly easy to identify if you have other wasps to compare with it. It has a very dark appearance, due not entirely to its having thicker black bars on its abdomen but also to the yellow being of a darker shade. All these social wasps by the way, except the hornet, are very much alike, but I do not propose to go into the minute differences between them. Identification of species has no part in this book. There are several works that go into the matter fully. The Norwegian Wasp is also a tree wasp, and more of a tree wasp than sylvestris, building its nest always outside in the open, generally in a bush and most frequently in a gooseberry bush.

Lastly we have the Wood Wasp, *Vespa austriaca*. It looks an ordinary social wasp and is hard to distinguish from the Red Wasp (it can be distinguished from it just as the German Wasp can be distinguished from the Vulgar one by having three black dots on its face instead of a black anchor mark). But this wasp makes no nest and breeds no workers. It is a parasite on the Red Wasp.

The nest of the social wasps is a remarkable edifice—whether in trees or in the earth—and great skill and an immense amount of labour go to the making of it. That is not to say that it bears comparison with the nest of the honey-bees. Its combs and cells are crude compared with theirs and incapable of bearing heavy weights. But then it is only a temporary affair. After a few short months its inhabitants depart to die or hibernate and leave the city to decay. The long, low-ceilinged halls echo vacantly. The cradles in their thousands lie empty. Vermin creep in: the mouse, the earwig, and the beetle keep the courts where Vespa gloried and drank deep.

The nest really commences in the autumn when one of the young virgins leaves the colony, frolics with some boy, and goes into winter quarters, a virgin no longer. She is not at all particular where she hibernates. She does not crave a hole; shelter from the wind and rain is all she asks, that and some fabric to hold on to. This fabric (it is often a curtain or a sack) she grips with her teeth and without any other support hangs there for six months. It is not our idea of an attitude conducive to sleep, but it is hers. Others of her race feel the same, for Ammophila, the caterpillar huntress, when she has finished her day's work and shut the nest up for the night flies to some tall grass and goes to sleep hanging from the side of the stem by her jaws. Her attitude is even more peculiar, for her body sticks out at right angles without support even from the forelegs. It looks more like a difficult muscle-straining circus trick.

In severe winters confirmed silver-liners, searching for some mitigating circumstance to balance lack of fuel and frozen pipes say, "Well, anyway, it will kill off a lot of those pests." It will do nothing of the sort. Temperatures that freeze the birds to death do not trouble the queen wasp, and the same applies to most other insects. What *will* hurt her, and reduce the wasp population the next summer, is a mild winter. The sleeping queen then wakes up and goes abroad. This uses up her reserves, for when hibernating in severe cold she is only ticking over slowly and her fuel consumption is practically nil. So the longer she stays quiet the better for her. Nature does not call upon her to do anything until late spring, when she will need all her strength—for she has a full programme ahead.

Undesirable as are her brood, one cannot but admire the lone queen in the heart-breaking task on which, in due course, she engages. The very thought of it would appal the stoutest amongst us. And it must be done alone. This gregarious creature, this lover of crowds, will have no one to help her, no one to pass by and exchange a friendly greeting. She carries, of course, a multitude with her. Forty thousand close acquaintances are in her loins, but she will not meet them yet.

So one day in late spring she leaves her curtain or her sack and prospects. She wanders along banks and hedges looking for a site suitable for development. What she decides on is said to be usually a disused mouse-hole. This is said to be the case with bumble-bees too. I do not presume to question it, but the fieldmouse is the greaest enemy of the bumble-bee, and if the bumble-bee is at all like her more advanced relative she would not go near any place that had the slightest smell of mouse. Having selected the site and gone down the mouse-hole or whatever it is and inspected it very thoroughly, the queen begins to hollow out a small chamber at the far end. Each bit of soil removed is carried out and deposited some distance from the nest. When completed, this chamber will have some root or anchorage of sorts showing at the top. The site being now prepared and the foundations dug she must get timber for the building.

She takes the air and goes round and round the outside of the mouse—or other—hole, and backwards and forwards, forming a maze-like pattern. She is impressing the place in her mind, a very necessary precaution with both bees and wasps. She is off at last, making a note of the general features of the countryside as she goes along, and after an examination of one or two timber yards in the shape of palings and the like alights on an oak gatepost. From the hard weathered surface of the post she gnaws some wood fibre which she makes into pulp with saliva and kneads into a pellet and takes home. For the mouse-hole is now HOME, and will continue to be so from now on (unless I happen to discover it).

This first pellet is the foundation stone of the future city of the wasps, though there is no laying ceremony. In time, and after ceaseless journeys to and from the old oak post, a canopy is erected supported by the roots at the top, or rather hanging from them. A wasp home is always begun from the top so that the ceiling is always the foundation. The various storeys, and later on there may be as many as ten of them or more, are supported by numerous pillars, though these pillars are erected downwards and the next storey attached below them. There is something very Alice-in-Wonderlandish about it all.

The queen now erects the first pillar of the nest. It is narrow at the top but widens out at its base and under this base, upside down of course, are made about four round cups. Everything in the wasps' nest is built of timber, sound, not rotten timber, but chewed up as it is and mixed with wasp saliva it is really paper pulp. In recent years we ourselves have discovered that this pulped wood is supreme as insulating material and have lined *our* houses with it in the form of sheets sold under various names. The queen wasp is a more expert paper maker than her children and in a nest her handiwork can always be distinguished from that of the others by the finer texture of the paper used. In each of these four or so cups an egg is laid and glued down—and the glueing part is important.

This is the busiest time of the queen's life, and she has not exactly dawdled before. She adds additional coverings to the roof in the form of scollop-shaped layers enclosing air between them and she extends the ceiling downwards in the form of half a globe encircling the comb that has been made—like an umbrella, and like an umbrella shedding any water that drips from above.

A woman's work, they say, is never done, and this is certainly true of the queen wasp; indeed I begin to get a little dithered and flustered myself merely by recounting what she does and trying to remember all of it. She extends the comb and adds more cells, and the walls of the cups already made and furnished with eggs are deepened and made at their extremities to take on a more or less hexagonal shape.

In a week or so, depending on the temperature, the first egg hatches and a tiny grub emerges, and were it like other grubs its first act on coming into the world would be to fall out of its cradle and perish. For the cells, you remember, are upside down. Unfortunately they have the situation well in hand even at this tender age and anchor their hinder parts inside the split egg which itself is glued to the bottom—or rather the top. Why they have to go to these elaborate pains to circumvent the force of gravity when they could do it quite easily by building the cells the other way round I do not know.

These first grubs must be to the mother the first faint glimmering of light ahead in the darkness of her ceaseless labour. For the present, however, they only mean added work.

Previous to this, with the exception of laying an egg or two, the queen has been solely but fully occupied with building and the manufacture and transport of building material; now she must also tend and feed a number of growing infants possessing insatiable appetites. This means she must go out and catch game and prepare it for them.

The queen mother has none of those finnicky preferences that are such a feature of the mother hunting wasps—nor have her children. Anything she can get will do. She therefore takes what is easiest to come by and nearest to her nest. Creatures that stay more or less put are favoured, such as caterpillars and aphides, so that up to the present the most confirmed wasp-hater has no cause even to shake his head. Indeed, if he withholds a nod of approval he is committing an injustice. No, it is not against the mother that we complain but what lies in her womb.

The grubs are mostly carnivorous, but unlike the hunting wasp grubs not entirely so. Later on, minced bee's belly containing a considerable amount of honey will often be the *plat du jour*. The grubs that we are studying soon swell and grow fat so that their portly forms begin to press against the sides of the inverted tubs that hold them. Wedged thus, they can again defy the law of gravity which at every turn they somehow manage to outwit.

The end of the grub, as a grub, is drawing near. It is about to spin its cocoon. Before it does so Nature decides on a good clear-out. We hear these days—through advertisements and elsewhere—a great deal about the evils of constipation, yet up to the present this grub, though eating at a tremendous rate and swelling visibly, has voided no faeces. It does so now—a black mass in a sack, the whole of its accumulated waste matter. And this sticks at the bottom—or should I say the top?—of its cell, and remains there. One does not expect a queen to clear it out, but later on when the nest is full of workers not one of them attempts to remove this sack of black offensive matter. How unhygienic! and how the cleanly honey-bees would shudder at the bare thought! True, there are scavengers in the wasps' nest, unpaid aliens who do a lot of the dirty work, but all you can say about them is that they *may* clear some of it out if they feel like it.

So these four, or more, eldest daughters of the queen spin their cocoons and lie quiescent in their silken coffins. To our minds a grub is almost everything that is unpleasant; something fat, pallid, squirming, revolting. Yet really the grub should give us hope. Scientists and theologians both, did they not know, would say there was no future for a grub, that nothing whatsoever could be made of it. Yet in nearly every case it turns, after death—for the cocoon state *is* death—into something winged, active, and beautiful. Who, after witnessing this change, can think that anything is finite or that miracles do not happen? The grub is a gross feeder. Not attractive at any time except to its mother or sisters it contrives to make itself even more repulsive by the way it gorges and bloats itself out. But after death we see that this gross feeding was not without justification. In the tomb, out of the tissues of bulging fat, something new is made. A strange contour appears round the cylinder. As if in unholy mockery it assumes vaguely the shape of its mother, but white and translucent like a swathed mummy or a waxen effigy. What is happening in that grub that should by now be decaying? You are wiser than I if you can say. If you suggest that it is a summary in a few days of what once took millions of years you are probably right—but it leaves us no wiser.

Meanwhile the mother, that energetic woman, has added to the comb and made more cells. She has added too to the enclosing envelope. And while she is working, the four waxen effigies in their coffins become more and more unlike a grub and more and more like insect corpses folded and laid out for burial. Then faintly, like the breath of life, comes a tinge of colour. The insect form grows clearer, more sharply defined, and the yellow and black ensign of the wasps is plain to see. All that remains of the grub is its skin, now a paper tissue tightly enclosing an almost perfect insect.

Then, one day, the eldest daughter bursts her paper bag, bites through the covering of her cocoon, and emerges on the face of the comb. Were some Hollywood director in control he would make a feature of this and we should witness an emotional scene. But there are no records of the mother taking the slightest notice of her first daughter, or the daughter of her mother. What happens is that the first daughter hangs from the comb to dry herself and for the second time voids her excreta, this time the accumulation of her pupal state and very necessary.

Becoming dry, she cleans herself all over, rather like a cat, giving extra care to her antennae, those mysterious organs whose functions we do not understand but which are important enough to be given a special slot for cleaning situated in the leg. Clean at last and not a little hungry she shuffles along the comb until she comes to a cell occupied by a grub. It she nudges on the head with her jaws and the grub obediently exudes a drop of liquor which is imbibed with satisfaction. One would have expected the opposite thing; the elder sister to feed the grub, but this is not the case. After that she nudges all the other grubs large enough to perform the same office, with the same gratifying result. The worker wasp starts her life therefore by sponging on her younger sisters. But some time the meeting between mother and eldest daughter does take place, for before long we see the daughter taking provender brought by the mother and distributing it amongst the grubs. In about two days she leaves the nest and tries her wings outside and fixes the position of the entrance hole in her mind, and soon, side by side with the queen, fetches food and paper to the nest.

One by one the others appear and every day new recruits are enlisted. When about twelve of them have got to work the queen "hands over." I have no doubt she does so with misgiving; I feel sure she is convinced the place will go to rack and ruin in the hands of others and I am certain she shudders at the sight of the new combs her daughters begin to make with their crude, coarse paper. But she can do nothing about it. Her function from now on is to lay eggs and no other work at all will be expected—or permitted. To provide the population that the wasps consider necessary for their nefarious business is a one woman job. And as the population grows so does the nest. The subterranean chamber is enlarged; workers by the hundred, and later by the thousand, issue, carrying in their mouths the loads of excavated soil. The thick paper envelope is dismantled and enlarged over and over again. The combs grow in circumference and forests of pillars support other combs that one by one take shape below.

And so for better or for worse—as far as you and I are concerned I fear for worse—the nest becomes a teeming city under very capable management. In time 7 or 10 or even 12 large pillar-supported combs are ranged in tiers and the outside envelope that started life so modestly is bigger than a football and two inches thick.

And here let us cast our eye over the efforts of the bee. We will not bother about the interior—no insect can rival or even remotely approach the combs of the bee with their exquisite workmanship and mathematical exactitude. But as regards the outside, the shell, comparison is possible. They work on entirely different lines; the wasp *makes* the shell of its house, the bee just discovers one and uses it. But having discovered and occupied the shell—whatever it is—and in some cases it seems most unsuitable—the bee immediately "converts" it. With its propolis, that hard resin which acts both as cement and bricks, it makes something that is *completely* immune from the weather, both wind and rain. The wasp paper envelope is not immune. It is immune enough for the few months of the summer for which it is required but the rains of November and February soon make pulp of it. I am rather fond of giving marks to insects in competitions. It amuses me and hurts no one. So for the inside of the nest I give, of course, the bee all the marks, and for the durability and waterproofness of the nest I give the bee the marks also. But the wasp is going to beat the bee on two points. The first is the insulation of the nest. In nature the bee usually selects hollow tree trunks; and wood, especially wood provided with bark, is a fairly good insulator; but it is not so good as the *papier mâché* of the wasps with its several layers enclosing fixed air. *And* the bees *don't* always choose hollow trees when left to themselves. They have been known to choose the inside of a metal statue in a market square and similar stupid places.

Why bother so much about insulation? it may be asked. Because a temperature of about 90° F. has to be maintained for hatching and rearing. The bees manage to do this wherever they are, just as they somehow manage to do anything they set themselves to do, but it is much easier for the wasps with their perfect insulation. Incidentally, I can only presume that wasps are immune from pneumonia, for if they were not, living in that hot-house and going outside on cold evenings and often frosty mornings several would certainly get it.

Secondly the bee is quite incapable of excavating. Certain solitary bees are supreme in the art, but we are talking about the honey-bee. The huge chambers the wasps excavate underground (those that do) are quite beyond the power of the bees.

Finally, if you think a queen ought to be a charwoman-cum-nurse-cum-brickmaker-cum-bricklayer-cum-navvy—which I don't—then the regal queen of the honey bees cannot hold a candle to the queen of the wasps. "But mark," says Evans, talking about bees, "with royal port and awful mien, where moves with measured pace the Insect Queen!" And personally I like my royalty to be dignified and to have beautiful white hands (or what corresponds to them) that never did any work. I admire navvies, but a world full of them would be frightfully drab.

The tale of the making of the wasps' nest is almost over. From a small beginning it becomes a great city; 50,000 inhabitants can boast of belonging to it. So far we have seen its rise; we must now recount its decline and fall.

Much stress has been laid by enthusiasts on the devotion of the worker wasps for the young. And they do care for the young, but how far this care is altruistic it is difficult to say. The bees' love of their sister grubs is single-minded and their care without wish for reward. Not so the wasps. They not only wish for reward but they insist on it. We have seen the newly fledged wasp visiting the cells and nudging the prisoners and getting payment. Subsequent extortion is not quite so brazen; food is given, but it has to be paid for. The grub pays by automatically exuding a sticky drop of fluid such as the wasp's soul loveth. It receives its minced fly and then it exudes the payment. Not always. *Some*times it tries to bilk. There is nothing very devoted then about the wasp nurse. Baulked of payment for the meal, she seizes the defaulter by the head and shakes it as a terrier shakes a rat—or getting on that way. Nor does she stop this brutal treatment of a helpless babe until she *is* paid. In this we see the seeds of the dreadful licence and butchery that occur later when the city begins to decay and discipline is relaxed.

I do not mean to say that payment is demanded every time a meal is served. The wasp grub is a boarder, and at fairly frequent intervals its account will be presented and if it is wise it will pay. Also, provided the grub is reasonable, it will get such care and attention as we in *our* boarding houses, however promptly we pay our bills, can never hope to receive. But what a vast gulf stretches between the wasps and the bees in this respect, with the latters' doting affection for their baby sisters! Nature has had to bribe the wasps to look after *their* charges.

Before we go on to describe the fall of the city, it is necessary to mention certain parasites. So far the parasites we have met have had but one object—to get their babies brought up by someone else. They have rarely had the courage to enter a nest and, if they have, have not stayed there long. The parasites of the social wasps are bolder. Several of them are beneficial and, indeed, indispensable to the wasp community. There is a two-winged fly that marches as bold as brass down the tunnel into the nest. It is not a walk that would commend itself to most, nor are the intolerant inhabitants of the city creatures whom many would care to visit—especially a fly, the favourite food of wasps. But this particular fly—its name is *Pegomyia inanis*—is unmolested.

During the war in strictly guarded military camps certain gentry, seated on carts, were suffered to come and go without question. These were they who cleaned up the refuse, without payment, for the sake of the "swill." *Pegomyia inanis* occupies an analogous position in the wasp camp. For the wasp is not like the bee: the nurses not only fail to keep the cradles clean but are none too particular themselves. They do not soil the actual nest but they soil the cavity in the earth below.

The Vespian paper globe hanging from some root underground has a space all round it except at the top. This allows the wasps access to every outside part for the purposes of enlargement or repair. The space is about an inch round the sides, but at the bottom it is deeper. It forms a pit, and this pit is used by the wasps as a latrine and a refuse-bin. Not only excreta but dead bodies (and there is much infant mortality) are thrown therein together with any other rubbish. Thus a manure heap forms which at that time of the year would become highly objectionable but for parasites. The parent Pegomyia, having entered, lays her eggs upon the paper envelope of the nest and the maggots, when they emerge, fall into the midden. On the unappetising material lying there they live and thrive, and the wasps—if wasps can assume such expressions—look on benignly.

Another fly that the sentries barely bother even to look at is a kind of drone fly, with the same Christian name as the other, *Volucella inanis*. She is black and yellow like the wasps but of quite a different shape; she looks as if she had been given an old coat by one of the soldiers. She too is a scavenger—or rather a breeder of scavengers—and her larvae clean out, by eating, the Augean stables at the base of the cells, as well as giving a hand in the midden. That her resemblance (in colouring) to the wasp has nothing to do with "protective colouration" is obvious for two reasons: she is not a bit like the wasp in shape (and the wasp, whatever else it is, is not a fool), and secondly it is her larvae that do most of the social mixing in the nest and the larvae are white little maggots. These larvae, when they don't fall into the cesspool, wriggle about over the combs, ignored by the nurses, and insert themselves in and out of cells (squeezing past the occupants) to get at the stuff at the base. The nurses tolerate these objects because they know exactly what sort of creature they are. Other maggots of similar appearance, introduced for the sake of experiment, are killed.

So far the parasites have been unpaid servants, house to house refuse collectors such as we ourselves have to pay rates for. Not all are so benevolent, notably a certain beetle that boasts the name *Rhipiphorus paradoxus*, and of all the parasites that prey on mice and men and insects none knows its job more thoroughly than this one.

From a parasitical point of view the snag attached to the profession is that one has to keep one's host alive. A chicken, for instance, providing sustenance for too many fleas dies and the outraged fleas have to seek fresh pastures just when they were nicely dug in. The same applies to multitudes of birds that frequently die when invaded by lice. Human parasites often come up against the same problem when their victim dies, financially or otherwise. *Rhipiphorus paradoxus* has evidently studied this side of the matter and its behaviour might well be taken as a pattern by all parasites who wish—and most of them do—to have their cake and eat it.

As so often happens in the insect world it is the immature young that display the cunning and do the damage. So, as a small larva, Rhipiphorus waits upon some wooden post and hopes that a wasp will come along. And sooner or later, if it is the right sort of post, a wasp does. I have never seen this, but scientists assert that when the wasp comes Rhipiphorus leaps upon its body. Several maggots can jump quite well, but I am surprised that one can so measure distance and direction as to land upon a selected target. But that indubitably is what happens. This manœuvre is purely for purposes of transportation and introduction to the wasp nest. The maggot will do no harm to its carrier and will alight as soon as it has been taken inside and is close to a cell containing a grub. It then eats a hole into the grub and enters its body.

With amazing discernment it avoids harming any part of the grub's anatomy that would cause serious inconvenience, but feeds only on the less important tissues. And feeding thus inside the grub, it grows. Under these circumstances there could be but one end—the wasp grub would die, and would probably be thankful to do so—but Rhipiphorus apparently realises this. It does not want the wasp grub to die; it has further uses for it. So it leaves the inside by boring a hole and emerges, looking much bigger and fitter than when it went in. Now the hole its plump body makes on its departure is larger than the hole made when it entered, and large holes in a living body are dangerous. Unless plugged, death ensues. The maggot of Rhipiphorus plugs the hole with its own skin, which it moults as it makes its exit.

Having had a comfortable stay inside, it proceeds to have almost as nice a one outside. It attaches itself to its friend and sucks its blood—or whatever passes for blood in a grub. At every stage it has been most careful about the grub's health. It has done everything to preserve it and has only left its inner berth because a longer stay would have jeopardised the grub's life. A considerate act. And it exercises the same restraint outside that it practised within, feasting again on the less important tissues and juices.

The climax of a grub's life is to spin a cocoon, and it is the parasite's wish that this grub should live to perform the feat. The parasite must practise self-denial and curb its appetite not a little to make its wish come true, for any thoughtless gormandising would cut the thread of that precious life. A gargantuan feast is to come, but for the present the maggot bides its time.

The day comes when the grub spins its cocoon, in the fond hope of emerging therefrom as a wasp. Something *will* emerge but it will not be a wasp. For inside the completed cocoon the Rhipiphorus maggot makes up for all its restraint by eating the entire grub. It is time then for its own metamorphosis into the beetle state and in this ready-made cocoon it effects the change. So this thorough-going parasite takes even the coffin of its victim.

It was stated earlier on that a social wasp, *Vespa austriaca*, was a parasite on the Red Wasp, *Vespa rufa*. This introduces a new type of parasite. Amongst some of the solitary wasps, females of closely allied species are parasites too, but theirs is a different and an infinitely easier task: they merely have to enter a relative's nest when the relative is away, lay their one egg, and go. The egg does the rest. For a female of the *social* wasps to enter a relative's nest is a different matter entirely. It is not a little unoccupied chamber that she has to get into but a teeming city with a queen already in residence and controlling thousands of devoted soldiers ready to tear any alien wasp to pieces. Moreover, Austriaca cannot just slip in and out. She must stay there and lay not one egg but hundreds;

eggs that do not fend for themselves but need as much care and attention, as many nurses, as much special food and for the same period of time as the eggs and subsequent larvae of the rightful queen. And we know how much *they* need.

How does she manage this? I do not know, and I have met no one who does. The interior of a wasps' nest is not an easy thing to keep under observation. But I think the bumble-bees enable us to make a good guess. This means going into some detail about bumble-bees, but I feel it is justified. Bumble-bees can be studied far more easily than wasps; also a bumble-bee's nest contains fewer inmates, and those inmates of peaceful disposition that rarely sting an observer. Hoffer, and particularly Sladen, made most exhaustive studies of what goes on in their homes.

Like the queen wasp the queen bumble-bee leaves her winter quarters when spring comes, prospects along some bank, and finally selects a place suitable for a home. She enlarges it, makes two crude waxen tubs, one for honey and the other for pollen, lays six or seven eggs, sits on them like a broody hen, feeds them when they emerge, and in short looks after them in every way until they are of age and able to do their share of the work. In time she too "hands over" and ceases to do any outside work, merely laying eggs and pottering about inside. It is a happy and hardworking little family that comes into being. At its peak it rarely exceeds two or three hundred members. The worker daughters give their mother none of those exaggerated attentions that the honey bees give their queen, but they are obviously devoted to her and the whole family muggle along amicably together.

In some cases, however, before the family has grown large, a strange bumble-bee appears and, in spite of her imposing stature and magnificent dress, stands diffidently at the entrance. Quite why the daughters do not attack her and send her about her business they do not know themselves.

By her size she is a queen, and her colours are those of their own mother. Her dress is cleaner and smarter than the mother's, but this is because she has never done any work. But it is something else that restrains them—a sort of hypnotism. In a few days the new-comer is mixing freely with them, and like schoolgirls with a "crush" on a mistress most of the daughters are now going out of their way to do her little services and to please her.

There are exceptions. One or two of the daughters have not fallen for the charms of this self-invited guest, and the mother's dislike is obvious. Ever since the strange bee came the mother has been unlike her usual self. Fits of sulking in corners have alternated with fits of hysterics when she has rushed about in jealous fury. But the new-comer is tactful and keeps out of her way, though the few unfriendly daughters she cultivates assiduously, trying to cast her spell over them.

It would seem a slight, an insignificant affair—one new-comer who is hurting no one and who cannot eat so *very* much of the precious stores—yet the atmosphere of the home has changed; it is unnatural, hectic, unhealthy.

Good-looking females with charm who are insinuating and diffident when they have an object in view often become less diffident when that object has been attained. It is so in this case. Before very long the visitor has the bulk of the inmates of that nest at her beck and call and flaunts herself arrogantly before the queen. The few daughters who still stubbornly resist her walk in fear and are often chased vindictively over the combs.

Obviously things cannot go on like this. Nor do they. The time comes when the intruder becomes so brazenly rude to the mother that it would seem as if she were in*cit*ing her to attack. And the mother does attack, and is killed. For Psithyrus (that is the intruder's name) wears armour impenetrable to the queen's sting but has herself a weapon of exceptional size and power. The loyal daughters—and a few of the others—attack the murderess in defence of their mother and are killed also.

Psithyrus's deeply laid plot is now apparent. She reigns in the old queen's stead. In the nurseries are eggs and larvae at every stage of development. These hatch out and having known no other ruler become the unquestioning subjects of the usurper. Psithyrus needs these slaves, for she herself is incapable of breeding workers. Her children (she has already begun to lay the eggs) will be fully sexed males and females incapable of doing work. So later on only Psithyrus males and princesses emerge from that particular bumble-bee nest and only Psithyrus queens live to carry on the strain.

As a rule Psithyrus enters a bumble-bee nest at its earlier stages, when the population is small. This means she must put off the murder of the reigning queen until that queen has laid sufficient worker eggs to supply her with her considerable requirements in slave labour. It might seem simpler for her to defer her visit until the nest is more populous and take it over then as a running concern. And sometimes she does—or tries to do so. It is a bad move. For some reason, when confronting a more numerous batch of daughters her fascination —or hypnotism or whatever it is—fails to work. The bumble-bee workers take the same view as their queen, and fall upon her.

I have said that Psithyrus carries a powerful sting and that her chitin is impenetrable to the sting of the bumble-bee; yet she has one vulnerable spot, in the neck, a target so small as to be negligible normally, but when a hundred stings are being thrust at her, one, sometime, must find this fatal mark. But the fight is bloody. Usually about a quarter of the whole bumble-bee population is killed before Psithyrus is laid low.

The name Psithyrus comes from the Greek and means "Whispering," referring to her buzz which is softer than that of the bumble-bee. In Britain there are six species of Psithyrus and each of these victimises one species of bumble-bee only. (Therefore since there are seventeen species of bumble-bee eleven of them are immune.) Moreover the Psithyrus queen is always very similar in appearance to the Bumble-bee queen whose home she invades. Obviously therefore she must at one time have been a member of that family; the descendant perhaps of a daughter that took to evil ways, or of some ancestral form before it acquired the social habit and the accompanying ability to lay worker eggs.

The wasp, *Vespa austriaca*, is another of the same type as Psithyrus. She too is similar in appearance to her victim—indeed she is almost indistinguishable from her—and like Psithyrus cannot lay worker eggs. She too confines her attention to one species only, *Vespa rufa*. The other six species of Vespa have no parasites of this type. What goes on when Austriaca has invaded Rufa's home we do not know, but, as I have said, it is not unreasonable to suppose that Austriaca works on the same lines as Psithyrus.

There is nothing of course to prevent the two queens living in the same nest and each bringing up young, the parasite "borrowing" the workers of the reigning queen. But I cannot see this happening often. In isolated cases, perhaps; but queens are jealous creatures, and two mistresses in a house—the one having no right there at all—make a combination that usually leads to considerable friction.

The scientist, Oswald H. Latter (to whose book I am indebted for a great deal of information) has sent me notes on some of his observations on parasites. Unfortunately they arrived after the book had been set up so I can only put them briefly, and must, moreover, lump them all together. These notes have not been published before.

(1) Examining the inmates of many nests of the German and Common Wasp, Latter found most of the males infected by a species of hematode worm. There is nothing remarkable about this: what *is* remarkable is that in no case were any of these worms found either in queens or workers, although many hundreds of the latter were examined. Latter draws

what seems to be the only conclusion, that some special article of diet is supplied to larvae destined to become males which is not given to queen or worker larvae.

(2) Watching an Ammophila (*sabalosa*) taking a caterpillar into her nursery, Latter saw a species of Tachinid fly sitting quietly about fifteen inches away watching the wasp's every movement. The fly remained motionless while Ammophila took her prey inside, stored it, came out again, and finally filled in the tunnel with sand. But the moment the wasp flew off Tachinid ran to the filled-in aperture and began to shovel away the sand. An alarming development this, from the wasp's point of view. Normally, once a burrow has been filled in the nest is secure from all but a very few parasitic invaders. I have heard the view expressed before that the Tachinid fly is rapidly changing her habits, so it may well be that in time she will become a really serious problem to the hunting wasp.

(3) At Hankley Common, Latter saw a Tachytes (*unicolor*) dragging a grasshopper and followed her. He was not her only attendant, for he soon noticed that she was being shadowed by a Tachinid fly at fifteen inches, which would appear to be the regulation Tachinid distance. And this distance was maintained with such precision that, so Latter says, the fly might have been attached to the wasp by a wire. Reaching her burrow Tachytes dropped the grasshopper and went into her nest. The fly then ran up and laid an egg (or more probably a larva) on the grasshopper. Latter put the grasshopper into a glass tube, and when he got home, two hours later, found the larva already busy at work eating the corpse.

(4) Colletes is a solitary bee that burrows in the ground. It flourishes in the Isle of Wight, and there, at Readar Hill, Latter saw a Tachinid fly sitting sunning itself on the face of a gravel pit. In due course a Colletes (*fodieus*) descended out of the blue, heading for its burrow. The fly took the air and went to meet it, and having met it followed closely behind. The bee descended and entered its burrow and the fly settled at a dis-

tance of a third of an inch from the burrow mouth, and waited there for twenty minutes. It backed away when the bee came out, but when the bee had flown away entered the burrow. At the same gravel pit another Tachinid also flew out to meet an approaching Colletes, but this one, getting near, suddenly lost interest and returned to its base. It had discovered that the bee was a male.

Latter has also observed Tachinids following *Odynerus callosus*.

It is after midsummer. The brigand city is large and prosperous. Pillage and loot come in from all quarters. The population numbers thirty or forty thousand and ten thousand babies lie in the cradles. And all this multitude the progeny of that once solitary queen. It is a model city: the strictest discipline prevails and everyone works hard. It would seem that such a thriving and efficient community must endure for ever; that nothing could shake the city's paper foundations. So, once, appeared Tyre and Sidon.

As autumn draws near certain imposing forms are seen among the citizens. They are larger, and their raiment brighter. They are the princesses and the sons, and they have been born and reared in the newest and larger bottom cells. These males and young females are difficult to distinguish except for one feature; the males have long antennae, curled foppishly outward at the ends, the females have antennae of ordinary length and without the exaggerated curl. Later in the year you may find males gathered in large hordes about the blossoms of the ivy—the last honey-bearing flower—and if you wish to impress your friends you may gather these large fierce-looking wasps in handfuls, though it is advisable before doing so to make sure that no lady is amongst them.

It cannot now be said with certainty that the whole population is the direct issue of the original queen. Some of the males may be her grandsons. With bees and wasps and certain other insects conception by a presumed virgin is no stain. There is no lifting of the eyebrows when an unmarried sister unexpectedly gives birth to a son, for as everyone knows, in Waspland sons have no father. This is all the more remarkable when one considers the extreme potency and keeping qualities of the male germinal fluid. Our queen's forty thousand or so female children were the result of one intercourse with a single male.

The doubtful grandsons are not the offspring of the virgin princesses. *Their* ovaries will be sufficiently occupied in about nine months time. They are the children of some of the nurses. This worker class, which is so strange and inexplicable to us and which is the whole backbone of the social insects, is not yet entirely under control, even by its originators. The secret (so far as *we* know) lies in the feeding and the ideal worker should be a completely sterile female. Things however do not always go according to the nurses' plans. It may be that some nurses are careless. Whatever the reason workers are quite frequently reared capable of laying eggs. They are male eggs, for workers have never yet been known to have sexual intercourse, firstly because this is impossible anatomically and secondly because no male would look at them. Frequently this procreative ability is latent, never even suspected by the owner and never exercised. But some encouragement may bring it out. With bees a missing queen will result in a number of the workers laying eggs, and egg-laying is a vice that grows, for once having started it they rather fancy themselves at it and prefer their own useless male-producing efforts to those of a queen. There is no return from this habit; a laying worker is a laying worker for the rest of her days. In the case of the bee the other workers take a poor view of it, but if no queen is there they allow it to continue. Why not? the nest is doomed anyway. But should a new queen be introduced—and her introduction will be exceedingly difficult on account of the opposition of the laying workers—the shift of these latter will be short, their sisters will massacre them.

With wasps, laying workers are much more common and there is less odium attached to it. They do it serenely, whether a queen is there or not, more or less as a pastime, or as a trick to impress admiring sisters incapable of such a feat.

The city is at its peak: workers, good-looking males, and elegant princesses throng everywhere. But in the midst of all this splendour the discerning onlooker can sense a different spirit. Often the workers would seem to resent the presence of their regal sisters. The attitude of the latter certainly verges at times on the contemptuous. Very occasionally distressing scenes occur and a worker tries to push one of blood royal from her path. The foundress of a future city will put up with nothing like that and the two unite in combat. It is not really serious. No swords are drawn though both carry them. It is a scuffle and it ends quickly. But it is significant; class warfare denotes that there is something rotten in the state.

And soon the princesses grow less in number. They care nothing really for the nest. It bores them. They prefer to be outside flirting with boys.

Then comes the last, most dreadful scene. With the going of the royal daughters the last shreds of discipline fall from the army. They invade the city, break into the nurseries, tear infants and eggs from their cradles and eat them alive. Whether the queen is killed also is not known. In any case she is worn out. Perhaps she is dead already. Perhaps it is her death and not the departure of the princesses that precipitates the invasion of the brutal and licentious soldiery. These are things we do not know.

It is the end. A few hang about in the city they have ravished till cold and hunger kill them. Others adopt the slogan, "Eat, drink, and be merry, for to-morrow we die." But they are not very merry. They immure themselves in ripe fruit and stay there, stupefied by the heady juices. The lassitude that presages death descends on all of them except the princesses who have now established themselves in winter quarters. Without the constant attention of the masons holes appear in the outer walls and moisture percolates inside. Hordes of barbarians invade the silent citadel, and that robber stronghold becomes the haunt of mice, ants, beetles, earwigs, woodlice, worms, and slugs.

CHAPTER 11

THE HORNET

THE HORNET is an ordinary social wasp and belongs to the genus Vespa, just as vulgaris and germanica and rufa and the rest and its name is *Vespa crabro*. Certainly it is of different appearance; larger, more powerful, handsomer. Instead of the crude, staring, black and yellow it adopts a softer scheme of orange, light brown, and chocolate. Popular fallacy attributes to the hornet a ferocity akin to that of a man-eating tiger. I have known a party having tea on the lawn grab the children and rush inside because an insect which someone identified (quite wrongly) as a hornet had appeared in the trees above. Brer Rabbit in his many schemes to do a bit of no good to Brer Fox or Brer Wolf frequently introduced them to hornets. Setting off once to dig out a hornets' nest I was regarded by my friends as one who, for better or worse, would not be seen again.

Actually, except in its dealings with those whom it regards as its lawful prey, the hornet is one of the meekest and mildest of insects. All it wishes is to be left alone to attend to its own affairs. Children have been found playing unharmed with these "pretty" things just outside their nest. On one occasion when out shooting I leant against the rotten branch of a tree and practically fell into a populous hornets' nest. I must admit I did not stay, but when I left, none of them attempted to follow me nor did any assault me during the brief period I was with them.

The venom of its sting is said to be something very extra special in the way of punishment. Books tell us that hornets' stings in numbers are invariably fatal to men. I do not know;

I have never been stung by one and I have met no one who has. Reaumer relates that a certain Don Allan Chartreux "having imprudently disturbed a hornets' nest was stung by one, which caused so much pain as to almost make him faint. He reached a convent with difficulty and remained for three days in a state of fever."

Well, that was not very nice, but as an isolated instance does not tell us much. An ordinary bee sting can bring the same symptoms to those susceptible. The fact that data concerning the effect of the hornet sting is so hard to come by is a certificate to the hornet of a non-aggressive spirit.

But as I have said, this non-aggression pact does not apply to what the hornet considers its lawful prey, and first on that list comes the honey-bee. This was where hornet and I came into opposition, and but for that bone of contention hornets could have come and gone to their hearts' content without let or hindrance from me. It was in Devon when I was beginning bee-keeping that hornets made a set at my bees. Now the hornet is a rare creature. When I left that spot in Devon and kept bees in the wilds of Cornwall and elsewhere I never saw one again. It just so happened that I had settled in one of their few strongholds. I was watching my bees coming and going on their lawful occasions when I saw a large orange and chocolate creature swoop down like an eagle and take a laden bee just as it was on the point of touching down. It then disappeared into the blue.

It became a regular thing after that; as often as not when I was watching the threshold of a hive down would swoop this form, gleaming with chocolate and gold, and another bee would be posted as missing. Sometimes the hornet would take the bee right off and sometimes it would take it to some tree where it appeared to do things to it, carving it up, I suppose, into suitable joints. This was very bad, but at no time did hornets arouse in me the fury that their black and yellow relatives did. The hornets' method was clean, if summary, and they did not pester the lives out of the bees by hanging around in mobs. And they did not interrupt the normal work of the hives.

Still, of course, war was declared. No one takes my bees with impunity. Had we been able to get together at some conference table I feel sure something could have been arranged, for unlike the wasp the hornet is a gentleman. But that was impossible, so I put on my war paint and prepared to storm their citadel. Unfortunately I did not know where their citadel was. With wasps I used to tie a thread to them, drench them with flour, and let them go. You could mark their flight this way for quite a long distance, and sometimes (not often) track them to their nests. But I could never catch a hornet. However, a hornet is pretty large and by observation over a period I got an idea of the direction from which they came, and searched trees there, but not a hornet did I see, still less the small procession that marks a nest. It was by accident and *a propos* of nothing that a farmer's boy told me casually there was a hornet's nest near his farm.

Feeling inwardly a little silly I got him to lead me to it. It was a hole in the earth under the roots of a large tree and occasional hornets were coming and going. I put a teaspoonful of a preparation of cyanide in the entrance. That is all that is necessary. Next day you can dig up the nest. There is a crowd at the entrance, all dead. Inside, the grubs are alive but the few adult inhabitants are very still. A grim scene really—especially with hornets who are so rare and so innocuous. A pity they like bees!

Having destroyed this hornets' nest I expected to see no more hornets, but the next day they were taking my bees as energetically as before. Evidently there were other nests. Again I tried to track them down, and this time, unaided by any farmer's boy, I found two. Like the other they were in the earth under the root of a tree, and the deadly cyanide did its work again.

This cyanide preparation I found useful for other things than wasps and hornets. It killed ants and cockroaches, and white fly in the greenhouse. It also nearly killed myself on one occasion. The gardener had "salted" the greenhouse with it one evening and closed the door and windows. In the morning I walked in as usual, knowing nothing about the anti-white fly campaign in progress. A cold in the nose prevented my smelling anything but soon a sledge-hammer began to knock against the inside of my skull. I got out, I imagine, just in time, for this was not really the proper greenhouse preparation but something much stronger. It was very forgetful of the gardener not to have told me about it. Granted we had had a disagreement three days before, but I can hardly think he had murder in mind.

Whilst on the subject of staff, we also had a maid at this house in Devon, and since it was through her I lost all my Africa and China field notes, including my observations on insects, it seems reasonable to tell the story here. She was a tall, strapping girl of sixteen who looked fully twenty-one and her name was Betty. I had a wooden study right away by itself in the orchard and one night I went there after supper. I found the waste-paper basket burnt out, the desk and chair charred and the chair upholstery glowing and smouldering. I was shocked. I am reasonably careful as a rule, but evidently I had dropped a lighted cigarette into the waste-paper basket when I had been there before supper.

The next morning I partially cleared out a sort of cubby-hole under the stairs of the house that was full of junk and rubbish. That afternoon smoke came pouring out of it and it took a large number of buckets of water to put the fire out. I got nasty looks from everyone—especially from my wife, who suggested that I had better give up smoking altogether. She pointed out (which I knew) that we had a child two years old and said she did not wish it burnt alive. I was humble and apologetic—and also worried.

The next day she and I went to Plymouth in the car. Opposite the house, at the back, was a large two-storied garage. In the upper storey I had stored most of my treasures; my African tents, kit, rifles, ammunition, telephoto and other cameras, trunks full of my China and Africa diaries, notes, and itineraries, and a hundred other things. Returning in late afternoon we saw a dark cloud hanging above the house. When we got there it was all over. The garage was burnt out. A fire-engine, a number of police, and several sightseers stood by chatting. A smiling Betty was handing cups of tea to the members of the fire brigade and gaily chaffing them.

The police sergeant interviewed me in the house. Had I been in the garage loft that morning? I had, as it happened. Had I been smoking? I did not know. Did I smoke a pipe or a cigarette? Both.

He was satisfied. The fire must have started from a cigarette end, or my knocked-out pipe . . . so much canvas and sacking . . . easily catches. To him, the two previous fires merely confirmed it. Obviously when I had finished a cigarette I invariably just chucked the lighted end away anywhere.

He asked another question. What ammunition had I in the loft? I said I had shot-gun cartridges. This, so far as it went, was true. He said the loud explosions and the massive things flying about to the no small danger of the firemen and spectators had seemed to him to come from much heavier stuff than shot-gun cartridges. Surprisingly he asked if I had shot any elephants in Africa. I said I had. With what? With .500.

Fortunately at this juncture a fireman came up with a question and the matter was never pursued further.

That night I retired as usual. But I put on a dressing-gown and stayed awake and from time to time softly opened the bedroom door, listened, and then softly shut it. That a cigarette end had lit the fire in my study I had believed—at the time. That one had lit the fire under the stairs I had doubted. That one had set fire to the garage I knew to be nonsense.

At about 2 a.m. when I poked my head from the bedroom door there was a distinct smell of burning. I went down. A large cupboard was alight in the kitchen, which was just under the nursery. My wife and I put it out. I knew who had done it now.

Living in the house besides ourselves (it was a big old rambling place, centuries old) were the gardener, a cook, a nurse, and Betty. We made a tour. Betty was in bed fast asleep—so were the rest. I stayed up for the remainder of the night and in the morning rang up the police. I knew who had done it because on the first occasion, when my study was partly burnt, both the cook and the gardener had been away at some function in the village and Nannie had been with my wife the whole time and was also an old friend.

Betty denied it, but the police sergeant was a fatherly man who kept giving her cups of tea and things to eat in the sitting-room and after three hours of this benevolent type of third degree she confessed.

It came out that in spite of (or because of) a wonderful mother who had sacrificed everything for her children the family had a kink. A brother of Betty's had knifed someone and there were hints of other things. I had annoyed Betty by some rebuke which, in court, she could not even remember herself. She therefore went to my study and set fire to the waste-paper basket and put it near the chair. This first fire had been like the taste of blood to her. She tried again, and again, and after the garage fire with all its thrill and excitement nothing on earth could stop her. She *had* to go on.

She was bound over for two years at the juvenile court at Totnes. She was lucky: in another month or so she would have been too old for the juvenile court and would have met with quite a different sentence. She went back to her mother in Plymouth and we never heard of her again. I often wonder. Perhaps this arson complex of hers was merely a phase of adolescence. I hope so.

Returning to the cyanide powder, it was also good for rats. Though not connected in any way with hornets, rats come into this section because they were so much a part and parcel of that spot on the Dart where I met my only English hornets. I had fallen in love with the place at first sight. House and garden were mellow and there was an orchard enclosed by a wall where I could keep poultry out of sight of the house. And it was cheap, even allowing for the fact that it had no electricity, gas, or main water. So I entered into the necessary negotiations and became the tenant for the next five years.

It was as charming when I moved in as it had been at first view and I was soon busy doing various things including making chicken runs and putting up houses in the orchard. The first jarring note was borne on the wind. There was a sewage plant close by and the indications were that it was not functioning as it should. The second was conveyed by word of mouth. A farmer said, "You don't mean to tell me you're going to keep poultry in that rat orchard of yours!"

I got my poultry and found that he was right. A rat orchard it was. The place was stiff with them. I thought cats might solve this problem. I got three half-grown ones from a farm, bred from guaranteed rat-killing strain. I kept them in a large barn in the orchard where I stored grain and mash. I fed them of course. A cat cannot *live* on rats; it must have other food to give it the strength to tackle them. I fed them in the mornings and once, coming back quietly, found the three cats sitting patiently in a row waiting until a huge mother rat with about five young had finished with their food and they could have their turn. I cannot say for certain, but I do not think those cats *ever* killed a rat; they had an inferiority complex with them and preferred chickens. The audacity of the rats was quite remarkable. They were to be seen at any time in broad daylight, particularly afternoon, eating from the chickens' troughs. I got a .22 and had great sport for several days, but they soon learned to see me coming and would lope off and take cover behind trees or grasses, or even in their holes, till I had gone.

In these pages you have witnessed many fights. Here is one of another kind: *Cockerel v. Rat.* I had a pen of half-grown Rhode crossed Light Sussex cockerels. I cannot say now what their age was but it cannot have been more than four months —less, I think. One late afternoon I was approaching this pen and saw an old grey rat feeding at the trough, with the cockerels standing by at a respectful distance. There was nothing unusual in this; what was unusual was that the largest of the cockerels had left the semi-circle and was advancing, as if on stilts, slowly towards the rat.

I stood still. The rat looked up, eyed the cockerel, and went on feeding. Mincingly the immature, ungainly form stalked on. The rat ceased feeding and watched it. The hackles of the cockerel were rising so I knew that something interesting might come to pass and stood as still as a rock. The bird's advance slowed down. One foot would be raised stiffly, to come down with a forward curving motion, toes outstretched. Then the other foot. The neck was stuck out and the hackles now were a huge ruff. This bird definitely meant battle.

The rat realised that too, and opened proceedings. It ran forward. It was one of those shooing-away runs; the rat wanted to get on with its meal, not to fight. The cockerel made a clumsy leap into the air and landed where the rat would have been if the rat had not jumped sideways. Annoyed, the rat swizzled round and made a low, curving, wicked leap towards the base of the cockerel's neck, but the cockerel with an awkward flutter got out of reach. The gloves were off. The other cockerels, necks craned, looked on, making throaty noises. One of them came forward as if to join in, but thought better of it and went back.

As the fight went on the cockerel's timing and judging of distance (after several lucky escapes) rapidly improved. The rat was a grey shadow that flashed about close to earth, the cockerel was a heap of angry feathers that bounced up and down on the ground like a ball. Those raking claws must have caught the rat at times as they descended and a cockerel's claws, even at that age, are not to be ignored as I have learnt more than once.

It ended suddenly with a dash by the rat under the wire-netting into the long grass, and I distinctly saw a red mark on its back. The cockerel watched it go, then jutting stiff wings against the ground, scratched and called out precociously to an imaginary hen.

The rats were killed by pumping the cyanide powder with a special pump into their holes in the ground and banks. At least, I hope they were. I never noticed any diminution in the population. Perhaps casualties were replaced by new-comers from the sewage farm wanting a change of diet.

In Africa a type of hornet used to make large nests inside dwelling houses, usually on the ceiling. I have never known any one trouble to destroy these nests until they were vacated; the occupants were so well behaved and everybody felt that sleeping dogs should be let lie. They never attacked sweating horses as the bees did, they troubled no one, and there was no mess—or very little—from the nest. In police barracks riotous and noisy evenings would occasionally take place under the influence of Cape "dop" and other stimulants, but the hornets were unconcerned by the turmoil below. I was, however, recently reading a book by a farmer's wife in Kenya, and she had a hornets' nest in a guest room. As usual, the hornets were left alone. Then two guests, a mother and daughter, came and were relegated to the guest room. During a fortnight's stay the hornets were good as gold, but when the guests were departing the daughter brought out a bright cerise-coloured scarf and wrapped it over her head. Instantly, so the writer avers, the hornets attacked her—or rather the scarf. She had the sense to fling the thing away and the hornets paid no more attention to her but remained with the scarf, thrusting their stings into it.

This seems strange to me, though I am not disputing the writer's veracity. Bees and wasps, as unnumbered experiments have shown, can distinguish between colours, and bees have quite a strong liking for blue. But though these insects may like certain colours there is nothing on record—except the above—to show that they *dis*like others. I myself have taken strong objections to the bright and ill-assorted colours certain women friends have worn but I have not gone to the length of attacking these women, and I consider that I possess much less patience and restraint than a hornet. Bees *do* object to certain smells of which ordinary carbolic and mouse head the list, and I dare say wasps are the same. So perhaps the lady had put some scent on the scarf of which the hornets disapproved, for it is a bit thick if insects are to dictate to us concerning the colour of the clothes we wear.

The nest of *Vespa crabro* is made of rotten, not sound, wood; consequently it has a thicker, coarser, more yellow appearance than those of the other social species. Hornets have another peculiarity; they work at night. When bees and wasps have retired indoors, the bees to work on rendering down the honey, the wasps probably to sleep, hornets keep on bringing in supplies, especially if there is a moon. Yes, an estimable creature, the hornet, but I do wish it would leave bees alone.

CHAPTER 12

THE DWARFS AND THE GIANTS

IN THE INTRODUCTION I mentioned the multiplicity of the wasp species and warned readers that I did not intend to stress these species overmuch. I gave my reasons then but now that we have gone over the subject it might be permissible to treat the matter a little more fully and in a more general way. When I said that Latin and Greek names in quantity made for difficult reading I was not arguing against their use. Certain naturalists, even in books dealing with classification, have given wasps, and other insects, English names. These names are merely a translation of the Latin and cause nothing but confusion. An elderly lady and a small boy were once seated in front of me on a bus. The elderly lady (obviously an aunt) said brightly to the boy, "You'll be going on a chou-chou to-morrow—won't it be nice!" The boy said "What?" The aunt repeated her remark and the boy asked what a chou-chou was. The aunt described it by classing it as a puff-puff. Light began to dawn on the boy and he asked her if she meant a train. The aunt said she did, though some of the strength seemed to have gone from her.

These translations are on a par with calling a train a chou-chou. When a naturalist describes the various wasps as The Pale-Footed Mimic, The Black Mimic, The Ornate Tailed, The Five-Banded Tailed, and so on through hundreds and hundreds of species one grows bewildered, dizzy—infinitely more so than with the Latin. And even if you remember these translations, it is largely waste of time; no one else will know what you are talking about.

The Latin names kill romance and beauty. The bare idea of using them for the nightingale or the rose makes one shudder, but with most of the insects whose species are numbered in thousands I see no other way. Moreover the Latin name may not be beautiful but it is not so ugly as the self-advertising labels that are given to some of our loveliest flowers. A rose that stuns you with its beauty and intoxicates you with its perfume will probably be called "Mrs. Harry Smith" or "Mrs. Bert Tomkins." Even if Mrs. H. Smith and Mrs. B. Tomkins look and smell like the roses they raised—which I doubt—they have no right to behave like Philistines in the matter of their names.

As everyone knows, in the scientific classification the genus (with a capital letter) comes first and the species (with a small letter) second. It is so very simple and foolproof—or would be if only the genera and species co-operated. The people who sort out these species are called systematists and at one time the systematists believed that every living thing *was* of a definite species; that a pair of each went into the Ark and came out again and that their descendants are with us to-day in unchanged form. The greatest of these earlier systematists was Linnaeus, and he laid down: "The number of species is as many as the different forms created in the beginning." So in difficult cases these harassed men went to endless trouble to find out what the species *was.* They made tests.

It used to be thought that members of the same species would breed together and have fertile children and that members of different species would do one of three things: (1) not mate at all, (2) mate and have no offspring, (3) mate and have sterile offspring, such as mules. So the systematists, when possible, tested their doubtful subjects this way, which was not only difficult but took a terribly long time. They behaved like chemists who analyse and test to find out which element they are dealing with. Actually their method was no use. Besides the three results mentioned animals of different species may have offspring that are fertile but sickly; offspring that are fertile but whose progeny is sterile; or offspring that may breed for several generations and then die out. And so on. In short, it was no test at all.

Now a creature like a bear is easy to deal with. You call the genus *Ursus* and then look round the various countries to see what different types of it there are and tack the species on behind. Thus the American Black bear you call *americanus*, the small Malay bear *malanayus*, and the Grizzly bear (having listened to hunters spinning their yarns) *horribilis*. A Giraffe is even easier. And there are animals that have one genus only and no species. But the systematists get severe headaches with other forms, particularly with insects and plants, and in the old days when they thought a species really was a species they must have gone almost mental. For even with such an obvious form as the tiger many variations occur. It is very large and long haired in the north; smaller and shorter haired in India; and very small in Sumatra. And in between these places it is gradated. Are these different species? Did one pair of tigers or more go into the Ark. Were one or about twenty-five created in the beginning?

But now the systematists have accepted the fact (gratefully I should imagine) that there is no strict dividing line between species in nature. It is entirely up to them. If they decide to class an insect that looks like another insect but has two more hairs on its hind legs as a different species, well and good. It does not matter in the slightest and gives entomologists the kick of adding another variety to their collection. As with philatelists who go into ecstasies over a stamp that has one perforation less or more than another stamp that is otherwise identical, it all adds to the interest even though some may think it is overdone.

So the whole system of nomenclature is now arbitrary. This suits us all. We just want to know where we are. We leave it to the systematists. Unfortunately they do not always agree. The British Association have ruled the matter thus: "A species is a group of animals that has been defined as a species by a competent systematist." The snag is obvious. Every systematist thinks he is competent, and no doubt is, but his views may differ from those of another systematist of similar unquestioned competence. This is not to say that there is confusion. In the main everything is cut and dried now. Also there is an easy way of settling many of the disputes. You put in a sub-species, the only drawback being that you have three italicised words instead of two. When some hunter goes to Africa, for instance, and gets a little off the beaten track and shoots a hartebeeste with a black mark on its tail or longer horns, or something, he likes to think he has found a new species. Like an explorer seeking uncharted country a hunter's fondest dreams are always of discovering new species. These systematists, who have quite enough species to deal with already, don't like it. Our hunter's idea (if his name is Smith) is for the hartebeeste with the black mark on its tail to be called Smith's Hartebeeste. It is a vain hope as a rule but the systematists, if Smith pesters them enough, may compromise and give him a sub-species as a special favour and call it *smithii*.

Apart from that, as I have said, our systematists occasionally disagree amongst themselves. To give an instance, British brambles have been divided into 62 species by one authority and 2 only by another.

Mankind, I think, provides the best illustration of the arbitrariness of this division of species. Whereas it often needs an expert to tell the difference between two species, *Homo sapiens* includes the midget bushmen of Central Africa, the Red Indian, the Esquimo, the Arab, the Zulu, the European, and the Chinese. And all these so dissimilar types are one species, they are all *sapiens*—at least in name. Nevertheless the systematists have done their work well, and it is extremely arduous work. It is annoying at times to find that a name you know has been changed, but I suppose it cannot be helped.

Having discarded the theory that species remain fixed for all time one is more or less forced to adopt the theory of evolution and try to trace the careers of one's subjects by means of the records of the rocks. It is like playing with a jig-saw puzzle that has nine-tenths of the pieces missing: fascinating but not entirely satisfying. In studying evolution one works backwards, following the spoor as it were in the direction from which the animal came, seeking its source as explorers for so long sought the source of the Nile. The geographical explorers eventually found the source of the Nile. The evolutionists will never find the source of life. Some think it came to earth in a meteorite; others think a dozen other things. Only one thing is certain—it did come.

Round about the sixteenth century (and probably before—I do not know) came thinkers such as Isaac Walton who decided that life originated from decomposing matter and even went so far as to give instructions on how to manufacture certain creatures from the raw material. (That wretch, the fly, and others like him were undoubtedly responsible for this. These somewhat impulsive observers saw filth silent and deserted one day and heaving with life the next and jumped to the conclusion that putrescence itself originated life.) Quite recently I got hold of an old book that gave full instructions on how to make a colony of bees out of an ox. I have forgotten most of the details but I know the ox had to be killed by having its mouth and nostrils stopped with mud. It was then more or less left to rot and when it was rotten enough the bees would appear. *Bees*—the cleanest of all creatures! The whole idea I suppose was taken from the story of Samson and the lion. There were other details about the killing of the ox involving the most barbarous and atrocious cruelty. It shook me when I read it; but I do not think I need have worried. An ox was and is much more valuable than a swarm of bees. Few I imagine would be prepared to sacrifice one—and forgo all its meat as well—on the offchance of bees appearing in its interior.

Pasteur finally squashed the idea that life came spontaneously at any time from practically nothing, and it is hard to realise now what a surprise this gave to everyone.

Reverting to evolution, the insects began their careers on earth at an infinitely earlier period than the mammals and by the time the first crude mammals left any record of themselves insects were firmly established. They had indeed almost reached perfection in their various types. During this period they had created the flowers and the flowers had created a large number of insects. We find a flower beautiful and like its scent, yet I often wonder why it appeals to us. For mankind is no earthly use to the flower and never has been. The colour and the scent are only snares. It is as if a woman put on her best dress and used her finest perfume to attract someone for what she could get out of him. And this particular woman gets nothing out of man. A flower to a dog or a cat is of no more consequence than a piece of paper or a bit of stone, and if a cow notices it it is only to weigh up its edible qualities.

When insects were young there were plenty of shrubs and trees but all propagated themselves after the fashion of the conifer or nut tree—the chuck and chance it method. They sent out a cloud of dust full of male spores. It worked, and still does, but it is wasteful and crude. The chance of an individual spore falling on the target was remote in the extreme. It meant that one plant must send out not a million spores but hundreds of millions. When we consider that some of our seams of coal are composed of nothing but fossilized pollen dust one gets an idea of the waste.

Pollen is nitrogenous and nutritive, and the insects were quick to realise it. They went after the pollen and got coated with it. And soon the plant perceived that it could make use of the insect. This may sound foolish, but from an evolutionary point of view a plant is quite as quick in the uptake as a man. So gradually certain plants came to place the male and female parts close together, relying on the insects and not the wind to effect fertilisation. The scheme was a success and caught on. More and more of the plants tried it, and soon competition came into play. Things like coloured bits of paper were displayed to show the insect where to go and guide it when it came back. So it went on, competition all the time becoming fiercer and fiercer. Certain flowers hit upon the stunt of giving sweets away, just as—once—gifts were attached to packets of cigarettes, and by colour and perfume each flower tried to attract more customers than its neighbour.

As the flowers developed so did certain of the insects, notably the bees. It might seem foolish of flowers, after going to all this trouble to attract insects, to go to more trouble to bar most of them from doing what the flowers wanted. They placed their sweets where only certain forms with certain lengths of tongue could get at them. A sort of under-the-counter trade. Actually it was a well-thought-out move; honey on tap in the open without protection is snapped up by the first comer so quickly and easily that he probably goes away without serving the plant any useful purpose—without in other words paying for his drink. Moroever he is not a regular customer and never will be. Flowers therefore began to hide their sweets, making it impossible for all but specialised forms to get at them. And even these would have to roll about and squirm right in and thus thoroughly dust the female organ with pollen—but it made advertisement more necessary than before. So when we see a field of flowers we are really looking upon a mass of posters advertising various drinks and toffee, and they are not meant for us at all.

The result was specialisation both in flowers and insects and it was at this time that the great Flower-Bee partnership was drawn up.

The insects witnessed the passing of the great reptiles during an exceptionally severe ice age, and then, probably with surprise, saw the rise to power of a little rat-like animal who originated the mammals. The insects had now conquered the world, and war with the rapidly developing vertebrates was inevitable. War was declared. During our own last war we heard many caustic references to sections of the community in certain places who "did not know there was a war on." In the war of the insects against the vertebrates not one of either party knew it, for it was an evolutionary struggle where forms strive to adapt themselves better than other forms and gain the best places.

But evolutionary warfare, when the issue is prolonged, is bound to lead to direct warfare also. So direct war was declared. The insects were well equipped. They outnumbered their opponents a hundredfold and were more than a match for them in every possible way—and still are. In running, jumping, digging, building, swimming, flying, they equal the vertebrates; in energy, ingenuity, and discipline they far surpass them, though as regards ingenuity an exception must be made of man, the latest comer to the vertebrate ranks who shares with a fellow non-flyer, the spider, the distinction of being the only creature who has thought out and used a mechanical means of air transport.

Why then have the insects with this overwhelming superiority in numbers and almost every other qualification, so far failed to oust us and the other vertebrates from the earth?

It is purely and simply on account of their size. The vertebrates started small but soon (we are thinking now in millions of years) attained an average size infinitely greater than that of the largest insect that ever appeared. And yet the insect is adaptable; it changes itself as circumstances require as we have seen in its dealings with the flowers; why then, having declared war, did it not grow big like its enemy and thus circumvent him? Is it perhaps, rather belatedly, doing so now?

It is not, and it never will. The great reptiles, to say nothing of the whale and the elephant and other larger mammal forms in between that have died out, have shown us that nature imposes no very strict restrictions on size. The Brontosaurus had comparatively small feet but a couple of its toenails were as large as a springer spaniel. Yet all the insects throughout the ages keep rigidly to a size never larger than about half that of a mouse. Why? The insect has the most efficient breathing system so far manufactured. It is beyond comparison better than ours or that of any vertebrate and gives the owner a hundredfold increase in energy. It does not dissolve oxygen in its blood and carry it to the tissues that way; it takes it in direct through numbers of tubes that branch out and permeate through the body. Our small throats—which are also required for a variety of other purposes—are the only passage for our air. This is not only a bad idea, it is also often dangerous. Think how we could run, and fight, if instead of gulping in air through the mouth we could get it from openings all over the stomach and chest. We should feel like a million dollars. We could run the whole course of the Marathon at the speed we now reserve for the 100 yards. But to possess this breathing arrangement and to get that feeling of aerated exhilaration we should have to be the size of an insect. There is no other way; the whole scheme goes to pieces in anything larger than a small mouse. For the oxygen can only penetrate to a certain distance; there is no pump or forced draft.

So this limitation as to size put insects at a great disadvantage in the direct fight on which they chose to engage. And let us thank God for it. With creatures such as Driver Ants the size of wolves none of us could possibly have survived, except perhaps as small dwellers in crevices.

It would appear that some of the insects realised their deficiency as single units and combined into armies. As such they had to be taken more seriously. Hives of bees have been used by men in primitive warfare and have scattered armies: wasps could do the same thing; while the driver ants who deliberately embarked on a career of aggression pure and simple still present the most formidable army the world has seen. Yet even the driver ants, in spite of their numbers, are not big enough to be really dangerous. Granted no form of life, including man, can stand against them, most of the larger forms *can* run away. It is only the smaller creatures and those unable to escape that are massacred.

A description of these driver ants might seem out of place in this book, but now that we are on the subject of war I think that the methods of the most redoubtable of the armies in the other camp ought to be mentioned. I am not suggesting that this army with its direct tactics is a dangerous one to us. It is not. The subtler methods of the food consumers and disease carriers are more to be feared. But it illustrates what the insects *can* do, in spite of their small size.

The wasps and the bees possess three adult forms; the driver ants possess five. First, the soldier, size for size the world's most formidable fighter, nearly ¾ inch long, reddish, with a head and pincers so large that the rest of the body is dwarfed. This soldier is the brains and director of the army. Second and most numerous is the worker, an ordinary looking ant, about ¼ inch long. She is the maid of all work but by no means to be ignored on that account, being almost as efficient as the soldiers in tearing chunks from living flesh. Third, a tiny worker who carries the eggs and larvae on the march. Fourth, Her Majesty, the Queen (and the army possesses one only), a huge, bloated, yellowish, bed-ridden cylinder like a sausage. (If you find one and preserve her in spirit the price used to be £5—it is probably more now.) She is carried on the march, and the workers bearing her look rather like mice staggering along with an enormous pumpkin. Lastly the males—harmless and unimportant like most masculine insects—magnificent winged creatures, larger than hornets and at a distance looking not unlike them. They have large eyes and are the only members of the family to possess them. The driver ants are purely carnivorous and nomadic. Every member of the army is completely blind, and, what is more, direct sunlight kills them.

From time to time the army—it is about a million strong—halts. When it halts it disappears. Of that vast number none are to be seen. They lie dispersed in various hiding-places—in holes, crevices, and on the branches of trees. Scouts are now sent out to explore the terrain. They miss very little, these scouts, and on the information they bring back the army's route is mapped out. If you are in a hut or a house in Africa and notice one day two or three driver ants mouching aimlessly about the place as if they were lost—Take Care! That same night—or the next—the army may invade you. It may not, of course; it depends on the information these apparently aimless ants (and other scouts that went elsewhere) give when they return. There may be richer booty in other places, or your house may not be in the line of march ultimately chosen. Let us hope, unless you have taken precautions, that it is not.

The scouting party returns and reports. Some of these will act as guides. And they are blind! That is what seems so extraordinary, so almost impossible. But, as I have said *we* depend so much on sight; to us sight is what crutches are to a one-legged man. A dog would think it an equal miracle if any creature did anything without the sense of smell.

The route is decided, the objectives fixed, the order given, and the earth belches ants. A million pour out from everywhere and form into line of march, roughly five abreast. The march commences, led by the scouts, and from first to last the strictest discipline prevails. Along the flanks run the big-headed soldiers, the officers, directing and frequently meeting in little groups apparently for hasty consultations.

Nothing living will stop that column. If one meets it it seems without beginning and without end, without head, as it were, or tail, a narrow endless file of marching ants. Anything in its path is destroyed; rats and mice in their holes, snakes, slow moving creatures like porcupines and chameleons.

Even the gigantic python that can swallow a man or an antelope is, if sluggish after a meal, killed and eaten. A caged fully-grown leopard in South Africa was consumed—all but the skeleton—in a few hours.

When a river or stream is in their path the column halts until a rope of ants has been formed. The rope is about an inch thick and composed of soldiers and workers locked together, though the ends, being subject to the greatest strain, are formed entirely of soldiers. One end is made fast to a tree or root on the bank, the other floats on the water or hangs from a height above until a suitable hold is found on the farther bank, which is grasped by many pairs of pincers. The army then proceeds travelling over the living bridge. In flooded areas or larger rivers, the ants form themselves into a multitude of balls crammed with workers and stores and covered outside by soldiers. These balls float and can endure several hours immersion. Being sensitive to light driver ants travel only at night or on dull days. Should they be caught by a patch of sunlight the soldiers form themselves into an archway under which the others travel in shade.

A house is invaded silently, generally at night. Everything inside the house that lives is killed. The whole place is systematically quartered. Small things are dragged out and larger things, such as rats and mice, followed into their hiding-places and put to death there. The only sound is a faint hiss from the packed masses of ants that cover walls and tables several inches thick, and occasional squeals from the victims.

Before morning the host will depart. Not a single ant will remain and the owner can return to a house that he will find very sweet and clean. All vermin from rats to bugs will have been wiped out—as also will his poultry and any stock he failed to set free. All his provisions, his bread, biscuits—anything except meat—will be untouched.

A man caught asleep is covered by the drivers who do him no harm at all until (presumably) a signal is given. Then all attack simultaneously. Each plunges in its pincers and pulls until the portion of flesh it has grasped comes out. That pincer grip—like the bulldog's—is one that never relaxes, even in death. The natives have put this to useful purpose. When they get wounds such as we would sew up they bind the edges together with the pincers of driver ants. It is a tricky job, but the ant is made to bite so that one pincer is on one side of the cut and the other on the other. The closing pincers hold the edges together and the ant's head—or rather its body—is then cut off. It is most effective surgery. Meanwhile, in one concerted movement hundreds of driver ant pincers dig into the sleeping man who springs up screaming, rushes out, and no doubt flings himself into the nearest water to try and get rid of them. I have never experienced it, though on one occasion I only just escaped in time, but I have met a man who has. He said that where the real torture came in was from the ants inside the ears tearing at the drums. The fate of a sick man, unable to escape, is better left undescribed.

A missionary once—because he thought the place would be safer from lions, hyaenas, and such—camped for the night on a small island on the Zambesi river. He went over to it, with his "boys," in their large native canoe. There was a kraal on the mainland and the "boys" asked him if they might spend the night there. Doubtless some jollification was scheduled. He gave permission, and they went off—in, of course, the one and only canoe. That night a driver ant army invaded the island. The missionary soon saw what would happen to him if he stayed there, but he could not get away because the boat had gone; nor did his cries carry to the kraal. The Zambesi is full of crocodiles. Normally one exercises caution even at its banks, especially in the dark. Yet the missionary, after a little more punishment from the ants, had no hesitation in wading into the river and staying waist deep all night. Miraculously no crocodile came, but since he expected one at any moment it needs little imagination to picture the feelings

—to say nothing of the discomfort—of the missionary that night. In the morning the natives returned and the driver ants had gone.

This incident is interesting, but personally I find it also a little sobering. Some time ago in a scientific book (I have forgotten its name and I only quote from memory) I read, "Man has at least progressed to the extent of having no longer to fear the carnivorous forms that at one time must have exercised his mind to the exclusion of almost every other consideration." Yet here was a modern man (with his famous gun, too) threatened on the one hand by descendants of the Great Reptiles, which we erroneously class as extinct, and on the other by a small form of insect life equally remote—and in very real danger from both. I get the impression of sinister forms, large and small, waiting and ready for the day when *their* turn comes back.

The war goes on and the outcome of it cannot be seen. Looking at it from our point of view mankind is in a vulnerable position. He cannot now live on what the earth produces naturally. He must "make" everything he eats; in other words he must grow his corn, his fruit, and his meat in special, big-yielding form. It is a new venture that has not been tried out before and the insects have been quick to perceive this weak spot. Corps of specialists have been sent to attack almost every corn, pea, bean, or plant raised by man. And if so many insects have learned to operate in so short a time how many more will be operating in a few hundred thousand years? In these attacks on our supplies it is numbers and smallness that count (the locust is an exception). So the small size that once so handicapped insects may in later phases of the war prove their greatest asset.

Fortunately insect preys upon insect, and we can even take advantage of that fact to press-gang certain insects into doing our fighting for us. All one has to do when plagued by a certain pest is to find some creature (it may have to be imported) that preys naturally on this pest, introduce it, and leave it to do the rest. The snag (there is always a snag) is that the preyer requires an abundance of prey and perishes when supplies become short—and then the supplies start breeding again. It is the same with the Hunting Wasp. An agriculturalist might be inclined to view large numbers of the Hairy Ammophila with pleasure as indicating that the grey worms must be almost on the point of extermination. But all they really *do* indicate is the presence of grey worms in large numbers. Nevertheless we must be grateful to the hunting wasps and to all the other insects who assist us in this grim struggle. We need all the help we can get.

THE END